REVIEW OF THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958

HEARINGS

BEFORE THE

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

NINETY-EIGHTH CONGRESS

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ROBERT S. WALKER, Pennsylvania

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REVIEW OF THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958

TUESDAY, OCTOBER 18, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Space Science and Applications,
Washington, D.C.

The subcommittee met, pursuant to call, at 1 p.m., in room 2318, Rayburn House Office Building, Hon. Harold L. Volkmer (chairman of the subcommittee) presiding.

Mr. Volkmer. Good afternoon.

The Subcommittee on Space Science and Applications will come to order.

Today the subcommittee convenes 4 days of hearings to review the National Aeronautics and Space Act of 1958 and the basic policy objectives contained in the act which have served to guide our Nation's civilian space program under NASA's stewardship for the last 25 years. Our purpose is to determine the adequacy of that space policy for NASA's next 25 years.

The national objectives set forth in title I of the 1958 Space Act have served our Nation's civilian space program well. There are many who believe they are adequate to guide our space policy over the next 25 years.

Yet, concerns have been raised that NASA may be approaching the future with less vision than accompanied NASA into her first quarter century. This may, in part, be due to a number of major trends which are significantly changing the character of the civilian space program.

Although NASA is still the largest single civilian agency in space activities, other players have become more visible in the arena, including other U.S. Government agencies, private sector organizations and foreign entities. How does NASA fit into this infrastructure?

As the space shuttle makes the transition from development to full-scale operations, a clearly defined role for NASA beyond the R&D phase remains undetermined, both for the shuttle and for other space transportation systems. Is it time that we defined NASA's role?

Space commercialization has become an important force in space activities and will accelerate, bringing with it the need for new business and legal understandings and arrangements. What should be the respective roles of Government and the private sector in accomplishing the goals of the Nation's space program?

The past few years have seen a growing emphasis on the military uses of space. While the civilian and military functions have remained separate, the increased emphasis on national security concerns appears to be causing some blurring of the two missions. Should these be further clarified in NASA's Organic Act?

The international dimension in space activity is gaining increased significance. As other nations expand their capabilities in space, our perspective as a world player will change, requiring an enhanced understanding and appreciation of international cooperation and competition. What kinds of changes should NASA make to reflect this perspective?

Our mission today and during the three remaining days of hearings is to determine whether NASA, as the lead civilian space agency, is positioned to meet the challenges of our space future in the face of rapid change and challenge.

The subcommittee hopes to gain a sense from our witnesses whether the policy objectives contained in the 1958 act adequately reflect the direction and scope of NASA's future, including whether NASA's ability to keep pace with changes in the space program is in any way limited by her current charter.

I would add that while the subcommittee will be considering language changes to the act, no specific legislation or amendments to the Organic Act are currently under consideration. One of the purposes of these hearings is to determine whether changes to the act are either desirable or necessary at this time.

I am pleased to welcome today two distinguished members of our subcommittee, Congressman Bob Walker of Pennsylvania and George Brown of California, who will be our first witnesses.

Later today we will hear from Dan Fink, Chairman of the NASA Advisory Council, who will present the findings of the Council's mission of NASA study.

I am also pleased to welcome Director John Gibbons of the Office of Technology Assessment, who will be our last witness. Dr. Gibbons testified last year at this subcommittee's hearing on national space policy. The OTA's major study on civilian space policy and two studies underway at OTA on international competition and cooperation in space and on the space station are of keen interest to this subcommittee.

[The prepared statement of Mr. Lujan follows:]

HONORABLE MANUEL LUJAN, JR.
HEARING ON THE REVIEW OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION ACT OF 1958
OCTOBER 18, 1983

THANK YOU, MR. CHAIRMAN. WHEN WE THINK BACK OVER THE PAST 25 YEARS SINCE THE SPACE ACT WAS PASSED, WE CANNOT HELP BUT FEEL A BIT AWED OVER ALL THE CHANGES THAT HAVE TAKEN PLACE. NOT ONLY THE HIGHLY VISIBLE ACHIEVEMENTS, LIKE THE APOLLO MISSION OR THE SHUTTLE DEVELOPMENT, BUT ALSO THE EXPANSION IN SCIENTIFIC KNOWLEDGE AND TECHNOLOGY, AND THE EXPANSION IN INVOLVEMENT. WHEN NASA WAS FIRST FORMED, THE FEDERAL GOVERNMENT MONOPOLIZED THE SPACE PROGRAM. BUT TODAY WE SEE A DIFFERENT SITUATION; A SITUATION WHERE THERE IS ACTIVE AND GROWING PRIVATE SECTOR INTEREST IN DEVELOPING THE POTENTIAL OF SPACE. THIS IS NOT SIMPLY INDUSTRY INTERESTED IN BEING A CONTRACTOR TO NASA, BUT INDUSTRY INTERESTED IN BEING ENTREPRENEURS IN SPACE. THIS BEGAN PERHAPS WITH THE EXPLOSIVE SUCCESS OF THE USE OF SPACE FOR COMMUNICATIONS, BUT NOW IS EXPANDING INTO THE AREAS OF COMMERCIAL LAUNCH SERVICES, FREE FLYERS, REMOTE SENSING, MATERIALS PROCESSING, AND PERHAPS EVEN COMMERCIAL SPACE STATIONS.

NOT ONLY HAS THE FEDERAL GOVERNMENT BEEN JOINED IN SPACE DEVELOPMENT BY U.S. INDUSTRY, BUT BOTH U.S. GOVERNMENT AND INDUSTRY HAVE BEEN JOINED IN SPACE BY A LONG LIST OF OTHER

COUNTRIES -- FRANCE, GERMANY, ITALY, JAPAN, GREAT BRITAIN, INDIA, AND THE SOVIET UNION, TO NAME A FEW.

IT IS NOT THE PURPOSE OF THESE HEARINGS TO SIMPLY REFLECT ON THE ACCOMPLISHMENTS OF THE PAST BUT TO THINK ABOUT THE NEXT TWENTY-FIVE YEARS OF NASA AND PERHAPS THE FUTURE BEYOND THAT. WHEN WE REFLECT ON THE DRAMATIC CHANGES OF THE PAST, WE CANNOT HELP BUT ANTICIPATE ANOTHER SERIES OF DRAMATIC CHANGES TO COME IN THE FUTURE. THE PRIVATE SECTOR INTEREST, AS I ALREADY SAID, PROMISES TO EXPLODE INTO A HEALTHY INDUSTRY OF THE FUTURE AND MAY DEEPLY AFFECT THE FUTURE DIRECTION OF SPACE PROGRAMS. PROGRAMS SUCH AS THE SPACE TELESCOPE PROMISE AN EQUALLY, IF NOT MORE EXCITING, EXPLOSION IN SCIENCE. I CANNOT HELP, THOUGH, TO THINK THAT THE PUBLIC HAS AS MUCH HOPE AND IMAGINATION FOR THE FUTURE ROLE OF MAN IN SPACE, AND POSSIBLY EVEN MORE, AS WE AND NASA HAVE. LOOK AT THE RECENT EXPLOSION OF MOVIES AND TELEVISION SHOWS: STAR WARS, BUCK ROGERS, STAR TREK, CLOSE ENCOUNTERS OF THE THIRD KIND, BATTLESTAR GALACTICA, THE MARTIAN CHRONICLES, AND THE HITCHHIKER'S GUIDE TO THE UNIVERSE. IN ADDITION TO THESE, THERE ARE A PLETHORA OF BOOKS, NOT EVEN COUNTING THE ENTIRE FIELD OF SCIENCE FICTION.

I AM HOPING THAT THESE HEARINGS WILL PROVIDE US WITH AN OPPORTUNITY TO EXAMINE THE POSSIBILITIES FOR THE FUTURE, TO REEXAMINE THE LESSONS FROM THE PAST, AND TO THINK CAREFULLY ABOUT THE APPROPRIATE ROLE FOR THE FEDERAL GOVERNMENT, AND BECAUSE NASA, IN PARTICULAR, IS CREATING THE FUTURE. I LOOK FORWARD TO WHAT OUR WITNESSES WILL HAVE TO SAY. I PARTICULARLY WANT TO WELCOME OUR COLLEAGUES, CONGRESSMAN WALKER AND CONGRESSMAN BROWN.

THANK YOU, MR. CHAIRMAN.

Mr. Volkmer. Let me welcome our first witness, Congressman Walker. I believe you have a statement. That will be made a part of the record, and you may proceed with the reading of the statement or summarizing, however you so desire.

Congressman Walker.

STATEMENT OF HON. ROBERT S. WALKER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF PENNSYLVANIA

Mr. Walker. Thank you, Mr. Chairman.

I will summarize parts of the statement here and then add maybe a couple of more items that occur to me.

First of all, I want to thank you for providing the opportunity to discuss some issues that I think are important for the future, although I do feel a little bit like the Pennsylvania legislator that I am told about a couple of years ago, who on the House floor raised some highly technical issues about a welfare bill that was up, and he couldn't get anybody on the floor that was able to answer them, so then he started—he would move from microphone to microphone, first asking the question and then answering himself. I feel a little bit like I am in that role today.

I want to say at the outset that I certainly agree with your contention that the Organic Space Act has served us well for 25 years and as a vehicle for serving the next 25 years seems to be well founded.

But there is abundant and well-documented evidence that the widespread benefits flowing from our space program and to the world at large, and that I think is a credit to the act. There have been spectacular advancements in the area of medicines, communications, meteorology, earth resources exploitation, navigation, aeronautical design, and many others.

Economics has been called the dismal science, but economists have long known that technological advance of the kind we have seen in the space program is the primary source of higher productivity and economic growth, and that research and development is the chief contributor to technology.

There is strong evidence to suggest that high technology efforts, such as our space program, have a far higher effect on the economy than most other forms of research and development.

The reasons for the high technological leverage of the space program are not difficult to understand. The most obvious is that industries involved in development of our space systems are among the technology intensive and innovative in the economy. As such, they are the world leaders in all the important technological stimulus, which the U.S. economy must have to improve productivity and expand output.

We must also be aware that these same industries are the ones upon which the Nation relies most heavily in our efforts to maintain favorable trade balances. Expanded exports of high technology products will offset the traditional negative trade balances in minerals, raw materials, oil, and low technology manufactured goods.

Therefore, it should be obvious that our space program is a crucial element in our overall economic program for the future. The manner in which our space efforts are structured over the next few decades may well make the difference between little or no economic growth on one hand and rapid expansion that is predicted by some experts, due to the commercialization in space, which could lead to as much as a new $1 trillion economy, meaning in 1983 terms 35 million new jobs by the turn of the century, as the other alternative.

This is my area of concern. How should we approach the future? There are some who tell us that we must approach commercialization in space with caution; that we should study and examine all the alternatives with great care; that we should commission the administration to undertake a major study of all the ramifications of potential commercialization and have them report back to the Congress.

We all know that that kind of study can take years and Congress can take many more years to consider the alternatives before some decision is reached. I would submit that had Queen Isabella demanded such a study before she pawned the crown jewels, Christopher Columbus might still be waiting for approval.

The problem, as I see it, is we must decide first what the roles should be for NASA in our future. For 25 years NASA has been on the cutting edge of technology. They have always been advancing the frontiers of science, and that is exactly the role which most Americans feel that NASA was designed to fulfill.

In recent years that role has changed through circumstances that were beyond NASA's control. As the shuttle program fell further and further behind and as costs on the shuttle escalated, NASA was forced to channel more and more resources into the shuttle and away from other programs.

While overall NASA funding stayed about the same level from year to year, less and less was available for anything other than the shuttle. The result has been that many meritorious, high-technology programs have been cut, and cut until they have lost all momentum, in order to keep the shuttle moving toward operational capability.

Now that the shuttle is ready to move from the developmental stage into full operations, we must make a basic decision: Do we commercialize the shuttle and allow NASA to once again become a research and development agency on the frontiers of science, or do we allow the shuttle, like a full grown chick, to remain in the nest?

This year I offered an amendment to the NASA authorizing legislation in committee which addressed this question. I suggested that we amend the National Aeronautics and Space Act to direct that our national policy would be to "seek to the maximum extent possible the fullest commercialization of those programs which have been proven by research and development."

I was pleased to learn that my views on commercialization are fairly closely shared by our colleague from California, Mr. Brown. Clearly this is not a philosophical issue or a partisan issue, but it is an issue that must be resolved before we can determine where the space program will be going over the next few years.

That is the reason why, Mr. Chairman, I think that it would be in the best interests of this committee to address the commercialization issue somewhere in that Organic Act. It is certainly the field of the future in space. The Organic Act is basically silent on that aspect of it.

It seems to me that we would do ourselves a favor to get on the train of the future, to begin to do the kinds of things within the Organic Space Act which show that we recognize commercialization for being one of the main avenues that we have to follow in the future in space, and we do so as quickly as possible.

I thank you again for allowing me to testify.

[The prepared statement of Mr. Walker follows:]

TESTIMONY OF REPRESENTATIVE ROBERT S. WALKER

Mr. Chairman and fellow members of the Subcommittee, on the morning of December 17, 1903, just eighty years ago, Orville and Wilbur Wright successfully achieved sustained flight in a power-driven aircraft. That first flight lasted only 12 seconds and covered a distance of 120 feet, just about the length of the Space Shuttle Orbiter. By their fourth flight of that historic day the Wright brothers managed to sustain flight for 59 seconds and traveled 852 feet.

The new technology of aviation had a slow beginning. There was no real governmental subsidy to encourage growth of the technology, and market forces were not yet existent to cause rapid growth. As we all know, World War I was the catalyst which caused interest in aviation, and accompanying growth, to reach unprecidented acceleration in the years which followed.

Twenty-four years after that December morning at Kitty Hawk, the Lone Eagle, Charles Lindberg, made the first non-stop flight across the Atlantic, and fired the imagination of the world. Sixty-six years after Orville and Wilbur's historic flight, Apollo 11 carried men to an historic rendezvous on the surface of the moon. Today, well within the lifetimes of many who remember that day at Kitty Hawk, the Space Shuttle has made access to space so routine that NASA is now considering sending news correspondents, artists and poets along on missions.

An entirely new frontier and a broad range of commercial opportunities have come into being in the 1980's with the advent of the Space Transportation System and commercially available expendable launch vehicles. We now have the ability to routinely and inexpensively transport a wide variety of payloads into low earth orbit. The costs have come down as our efficiency has gone up, and businessmen are looking into a broad range of potential commercial activities to be conducted in space in the near future.

To quote the NASA publication "Space Shuttle",

"With its versitility and reusability, the Space Shuttle will truly open the door to the economical and routine use of space. As a transportation system to Earth orbit, it will offer the workhorse capabilities of such Earthbound carriers such as trucks, ships, and airlines and will be as vital to the nation's future in space as the more conventional carriers of today are to the country's economic life and well being".

But, as we stand poised, ready to move with confidence into a new era of space exploration, and exploitation, in which we will have the ability, and the opportunity, to regularly lift large payloads into space on a highly economic basis, shouldn't we take the time to examine the policies under which we manage our space efforts.

There is abundant, and well documented evidence, of the wide-spread benefits flowing from our space program to the nation, and to the world at large. There have been spectacular advancements in the areas of medicine, communications, meteorology, earth resources exploitation, navigation, aeronautical design, and many others.

Economics has been called the dismal science, but economists have long known that technological advance is the primary source of higher productivity and economic growth, and that research and development is the chief contributor of technology.

There is strong evidence to suggest that high-technology efforts such as our space program have a far higher effect on the economy than most other forms of R&D. The reasons for the high technological leverage of the space program are not difficult to understand. The most obvious is that the industries involved in the development of our space systems are among the most technology intensive and innovative in the economy. As such, they are world leaders in that all important technology stimulus which the United States economy must have to improve productivity and to expand output.

We must also be aware that these same industries are the ones upon which the nation relies most heavily in our efforts to maintain favorable trade balances. Expanded exports of high-technology products will off-set the traditional negative trade balances in minerals, raw materials, oil and low-technology manufactured goods.

Therefore, it should be obvious that our space program is a crucial element in our overall economic program. The manner in which our space efforts are structured over the next few decades may well make the difference between little, or no, economic growth on the one hand, and rapid expansion projected by some experts due to commercialization in space which could lead to a new trillion dollar economy meaning in 1983 terms 35 million new jobs by the turn of the century, as the alternative.

This is the area of my concern. How should we approach the future? There are some who tell us that we must approach commercialization with caution. That we should study and examine all of the alternatives with great care. That we should commission the Administration to undertake a major study of all the ramifications of potential commercialization and have them report back to Congress.

We all know that that kind of study can take years, and the Congress can take more years to consider alternatives before some decision is reached. I would submit that had Queen Isabella demanded such a study before she pawned the crown jewels, Christopher Columbus might still be waiting for approval, and the new world might still be undiscovered.

We have reached the point in our space exploration efforts at which we must make some fundamental choices. There are a number of companies and a number of individuals, who have indicated that space is ready for commercialization now. There are companies that not only are willing, but which actively want to operate space transportation systems. There are companies which are ready to move aggressively into the area of expendable launch vehicles. There is a tremendous potential for private sector involvement in space activities.

At the same time, we must guard against channeling commercialization into blind alleys. For example, the Heritage Foundation believes that we are rapidly moving toward what they characterize as a Space AMTRAC. I believe that we would all agree that would be a tragedy.

The problem, as I see it, is that we must decide first, what role should NASA play in the future. For twenty-five years NASA has been at the cutting-edge of technology. They always have been advancing the frontiers of science, and that is exactly the role which most Americans felt that NASA was designed to fulfill.

In recent years that role has changed through circumstances which were beyond NASA's control. As the Shuttle program fell further and further behind, and as costs on the shuttle escalated, NASA was forced to channel more and more resources into the Shuttle and away from other programs.

While overall NASA funding stayed about level from year to year, less and less was available for anything other than the Shuttle. The result has been that many very meritorious high-technology programs have been cut, and cut, until they have lost all momentum, in order to keep the Shuttle moving toward operational capability.

Now that the Shuttle is ready to move from the developmental stage into full operations we must make a basic decision; do we commercialize the Shuttle and allow NASA to once again become a basic research and development agency on the frontiers of Science, or, do we allow the Shuttle, like a full grown chick, to remain in the nest?

This year I offered an amendment to the NASA authorizing legislation in Committee which addressed this question. I suggested that we amend the National Aeronautics and Space Act to direct that our national policy would be to, "Seek to the maximum extent possible the fullest commercialization of those programs which have been proven by research and development."

I was pleased to learn at that time that my views on commercialization are closely shared by our colleague from California, Mr. Brown. Clearly, this is not a philosophical issue or a partisan issue. But it is an issue which must be resolved before we can determine where the space program will be going over the next few years.

Mr. Chairman, at this time I cannot say how we should best move toward full commercialization of our space activities. But I know that we must move in that direction as quickly as possible.

In recent years we have seen an ever greater portion of NASA funding moving toward the Shuttle. That has led to the loss of critical mass in many other NASA scientific activities. We are now at a point where we have a fine spacecraft system which has an unlimited potential. But, if we maintain the operational responsibility in NASA as it is today, there will be no resources left over for NASA to do anything else.

A quick, and admittedly rough, analysis indicates that at the minimum, each launch of the Shuttle costs NASA about $200 million, after user fees are recovered. A simple calculation indicates that at present funding levels if we reach 24 launches a year, there will be barely sufficient funding available to NASA for Shuttle launches, and that everything else will starve.

Mr. Chairman, this Committee knows better than any other that we still have an entire universe out there to explore. America has a destiny still before us beyond the confines of the Earth. In the near term we can see space stations inhabited by the new pioneers, and in the not too far distant future we hope to see man's great leap to new planets and beyond. It is time for us to turn our attention, and our resources, to the vastness of space, with full confidence that American free enterprise will continue to nurture and develop the solid foothold NASA has established so far.

Mr. **Volkmer**. I am sure I know what the answer is, but you do not believe that the Organic Act in itself, since it doesn't specifically provide for commercialization as a positive factor, should have that positive statement in it? Is that your position?

Mr. **Walker**. Yeah. I think it would make a lot of sense to have that kind of language in the act so that we could distinguish the fact that we recognize commercialization is a major part of our space efforts in the future and that we distinguish where NASA's role is in commercialization, that they are to remain on the leading edge of technology and spin off into commercialization that which they can to the maximum extent possible.

Mr. **Volkmer**. Do you envision—we have a possibility that we may be going into a concept known as man's permanency in space or space station. Do you envision commercializing that immediately or in the future?

Mr. **Walker**. Well, I think some aspects of the space station could probably be commercialized from the outset. One of the ways in which we might be able to justify the cost of the space station would be to assure ourselves that the design of that station included the capacity for privately launched vehicles to be served from the space station and thereby assure ourselves that private capital, as well as public capital, goes into the building of that station.

So I would hope that as we arrive at a conclusion about a space station, I hope—I am very hopeful it is a positive conclusion. I am an enthusiast for the space station, but I would hope that it would include commercialization aspects as well as those things which are research and development oriented in the Government programs.

Mr. **Volkmer**. One last question. In the event that we would include in the Space Act language of positive note to get into commercialization of space into the private sector, would we put in there that NASA should be the lead agency to do that?

Mr. **Walker**. Well, I don't think that I have resolved in my own mind whether NASA should be the lead agency in some of these areas. We are going to have a series of discussions I think about lead agency status, and I haven't totally resolved that in my own mind.

I would say, though, that I think insofar as the Organic Act is concerned, that all I really want to say is that NASA, insofar as it can, should spin off to the maximum extent possible those things which they have brought through research and development and are now available for commercialization.

I don't think that we need to say in the Organic Act exactly how commercialization should take place and who ought to be doing the commercializing within the Government. In fact, I think probably the less Government the better in many aspects of commercialization. We ought to only be in those areas where it is absolutely essential for Government to be, such as in international commitments and in certain regulations with regard to public health and safety.

Mr. **Volkmer**. Does the gentleman from Washington have any questions?

Mr. **Chandler**. No.

Mr. **Volkmer**. Does the gentleman from California have any questions?

Mr. **Brown**. No.

Mr. **Volkmer**. We have a vote on.

NASA can commercialize at the present time without the Organic Act being changed. We are seeing that——

Mr. **Walker**. Oh, I don't think there is any doubt about that.

Mr. **Volkmer**. We are seeing that in ELV's and things like that and proposals.

Mr. **Walker**. I think that under the Organic Act there is enough flexibility to certainly move toward commercialization. But I think that a positive statement within the act would show that we recognize that the next 25 years are going to be a little different than the last 25 years and that commercial activities in space are going to be a part of that next 25-year period.

Mr. **Volkmer**. All right. I appreciate your testimony here today. I know of your interest in this from back when we had the authorization language you propose. So at this time, unless the gentleman from California—we have a vote on. Do you want to come back, have your testimony at that time?

Mr. **Brown**. Yes.

Mr. **Volkmer**. We will now recess, but before we recess I ask unanimous consent, since we already have photographers taking pictures, that still photography be permitted through the rest of the hearing. No objection, that will be so ordered.

We will recess until about 1:35.

[Recess.]

Mr. **Volkmer**. For the record, the committee will come to order.

At this time I would like to ask unanimous consent that the statement of the Honorable Manny Lujan, the ranking minority member of the committee appear in the record immediately following my opening statement and prior to Mr. Walker—Congressman Walker's statement.

Mr. **Volkmer**. At this time I welcome Congressman Brown of California to the hearing. As I understand it, you have a statement that will be made a part of the record. You may either review your statement in full or summarize, however you so desire. And we welcome you here today.

STATEMENT OF HON. GEORGE E. BROWN, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. **Brown**. Thank you very much, Mr. Chairman.

I will go through my statement. It helps to keep me organized a little bit better. And then I will supplement it a little bit.

I do appreciate the opportunity to testify. I have been concerned about the need for some refinement of our civilian space policy in particular for a number of years.

We need to ask ourselves two questions as we review the act: How do we recommit ourselves to the policy principles set forth in the act—and they are truly an excellent set of policy principles—and where has the act proven inadequate to meet the evolving space program?

We conduct our own yearly reviews of the NASA programs, but these programs in themselves do not make policy. As members of this committee, we have a unique responsibility to take the long-range view for science and for space. It was this long-range vision that provided the framework for the act 25 years ago. We need to take a look at these questions again. We are in the midst of a space revolution, and I am concerned that we in Government may have taken too short a term view of our role.

We must keep in mind that the space program is much bigger than it was 25 years ago, and there is more and more overlap of space technology with many sectors of our society. Communications, military applications, and international relations are just a few examples of areas that have grown in importance since the 1958 act.

This makes our review of space policy much more complex. To help us, I would recommend a joint congressional committee review of space programs and policy formulation in those areas where there is overlap in committee jurisdictions.

We cannot afford to isolate ourselves in the midst of a space revolution, or the space debate will proceed without our input. If we allow this to happen, our committee review could become obsolete and ineffectual. For example, I would strongly encourage joint hearings with the Armed Services Committee or the Foreign Affairs Committee or joint hearings with the Senate to elevate the visibility and discussion of space policy and program issues.

I also recommend that a new civilian Senior Interagency Group [SIG] on Space be formed as a counterpart to the currently established SIG, which is chaired by the President's National Security Adviser. This approach, or the cochairing by the NASA Administrator of the current SIG, would help to insure a strong voice for civilian space programs and balance the heavy military emphasis that has developed.

Space science, space application, military civilian activities, commercialization, NASA space operation responsibilities, and international cooperation are areas that have come increasingly under budget in policy debate and which have challenged the policy principles set forth in the original act. I would like to discuss each of these very briefly.

Space science, although funded at a historic low, is in better shape than it has been in the past few years. This is a result of the excellent work of the Solar System Exploration Committee. Rumors of the demise of the planetary exploration program by this administration prompted the formation of the Solar System Exploration Committee as an ad hoc group of the NASA Advisory Committee.

The SSEC planned a coherent, long-range solar system exploration program with scientific merit that can be performed on a comparatively low budget. A core program for exploration of the solar system was devised that can be supported through times of constrained budgets. An expanded study is being conducted to develop the outlines of a program to accommodate future increase in funding. In any case, the SSEC's recommendations need to be supported with adequate funds.

This committee and its study could serve as a model for planning in other areas of space activities. It contains many of the ingredients for the establishment of a successful program. Scientists directly involved in the field and performing the research contributed to the study. The planning was long range in nature, while building on current programs, and funding is projected at stable, reasonable levels which protect high quality, scientific results.

NASA conducts similar exercises in other areas and is involved in a space commercialization study currently. My praise for this approach falls short of 100 percent endorsement because of my belief that NASA ought to be getting advice from a more independent source. The SSEC, as I mentioned, is part of the NASA Advisory Committee, which is an internal NASA organization.

The statutory establishment of a Space Advisory Board, responsive to both NASA and Congress, could serve to provide more independent advice on U.S. space activities. The Space Advisory Board could be modeled after the EPA's Science Advisory Board or the Department of Energy's Research Advisory Board.

It could perform a visionary function for Congress and for NASA and help us to structure a strong and coherent space program. If we do not actively seek outside advice, we will tend to make policy and programs on a closed loop between NASA, the Hill and special interest groups.

With regard to commercialization, I am skeptical about the administration's proposal to commercialize the land remote-sensing system. It appears to me that what the administration is doing is merely to move Landsat off budget and calling this process commercialization.

A more efficient approach to promoting the applications and commercial use of space technologies developed by NASA would be to support aggressive applications, technology utilization and technology transfer programs across the board.

In agriculture, for example, applications of Landsat technology look promising in prediction of water supplies, inventory of natural resources and agricultural resources, prediction of agricultural soil loss and monitoring and detection of healthy and diseased crops.

NASA should be allowed and encouraged to conduct operational programs and applied research, as well as basic R&D, if we hope to see Landsat technology or other technologies develop through our space programs, see them through to the commercial stage.

NASA's Technology Utilization Office and space application activities help promote the commercial use of technologies developed through the space program. In order to emphasize the importance of these activities and help NASA identify commercial use of technologies developed through its research program, we could and, in my opinion, we should combine the technology utilization program, the space applications program, and commercialization activities into a separate Office of Space Applications and Commercialization.

A major weakness in our space policy and programs is our inability to define and carry out the process of commercialization. We have had considerable experience in doing this with other technologies. Commercial aviation and nuclear power come to mind. But we still lack a conceptual framework which allows us to take reasonable action.

Combining these two functions into a separate and enhanced Office of Space Application and Commercialization, with higher visibility and greater policy attention, would be a natural step to take and would help promote better use of space technology.

It is difficult to see how we will retain a leadership role in space without some action of this sort. NASA's space science program would then be centered in a separate Office of Space Science, and this approach would benefit space science by separately emphasizing the importance of its mission for planetary exploration, physics, and astronomy.

Let me make a few other observations with regard to commercialization.

By far, the most successful example of commercialization of space-derived R&D is in communications. The Congress acted wisely many years ago to set up Comsat, to exploit the development of space communication. In doing so, however, I think its success was largely accidental in the sense that there was an established market there—and Comsat has exploited that market successfully—but it was also dependent upon a new innovation, the establishment of a global communications system; namely, Intelsat. And it turns out that this in itself was an extremely creative act which helped developed the global market in a very effective way.

There are problems there which we have encountered. For example, because we gave Comsat a monopoly position, there was no incentive for Comsat to engage in the long-range research essential to maintaining the growth of this burgeoning new commercial activity. And as a consequence, NASA, after moving out of the long-range communications R&D had to move back into it again.

Defining the role in fields such as advanced R&D between the Government and a monopoly private entity is extremely difficult. It leads me to conclude that we would do best in terms of commercialization when we do not create monopolies but instead have an active, competitive market, and that the circumstances need to be very carefully studied in order to make sure that we maintain the proper relative amount of effort in the long-range R&D which is so essential in a rapidly changing field of this sort.

It also leads me to feel that we have neglected, in thinking of modes of commercialization, the importance of international cooperative activities, institutions such as Intelsat.

You will recall that we gave some attention in one hearing to the possibility of an international role in the management of the meteorological satellites. There are possibilities for international role in the management of other systems. I am thinking of, for example, the global positioning satellite system, which is about to be deployed, and which, incidentally, ought to be made available to all civilian aircraft and civilian shipping around the world in order to avoid tragedies, such as the Korean Air Lines accident.

That kind of a system needs to be considered in an international or global framework, and in our thinking about commercialization, we have given completely inadequate attention to this. And I feel very strongly that not only could this expedite commercialization, it could vastly enhance our leadership role in global space policymaking in a way that would benefit us in many ways, as it has in the international communication field already.

Now, if I may proceed to one or two additional points. I have been personally concerned about the relative military civilian roles in space in this country as it has been developing. The erosion of the distinction between military and civilian activities in space is contributing to the reveral of the tradition of openness which characterized the first 25 years of the U.S. space program.

As we all know, the military's yearly space budget now considerably exceeds NASA's budget, and even in NASA's budget, a substantial proportion, perhaps 25 percent, can be attributed to military activities.

We are only beginning to grapple with the scientific, international, and economic implications of this drift toward the militarization of space. The civilian program can benefit greatly from military programs and already has, as I have frequently mentioned, but the original act calls for separate, although coordinated civilian and military programs.

What are the costs and what are the benefits of cooperation between the two sectors? Mr. Chairman, some may want to see NASA become a support agency for the military. Some may want no interaction at all, although I know of no strong opposition to cooperation on some levels with the military. Regardless of the individual beliefs that we hold, we cannot afford to ignore military and civilian interaction and conflict in space or we will surely deal ourselves out of a major emerging policy debate.

As I have indicated earlier, I think that we need to give considerably more attention to the international aspects of space. International cooperation serves many functions, and it is extremely important to continue to support it.

Political, scientific, and economic benefits can be derived from international cooperation. On the political level we increase good will and national prestige by cooperating with other countries on projects and we can, as we know, in many ways contribute to the development process in the third world through cooperation and high technology areas, such as the space program.

My conclusion, Mr. Chairman, is that the act is basically sound but that we need a new, far-sighted application of the policies in it to make it effective and a consistent budgetary approach to make it work.

I encourage this committee to take a comprehensive look at the space program, jointly with the other committees that I have mentioned where appropriate, and to help devise an aggressive approach in support of space science, space applications and commercialization, international cooperation and, at the very least, an equitable distribution of work and transfer of technology between the civilian and military space program.

Thank you, Mr. Chairman.
[The prepared statement of Mr. Brown follows:]

Statement of Congressman George E. Brown, Jr.
Before the House Committee on Science and Technology
Hearings on the NAS Act of 1958
October 18, 1983

Mr. Chairman, thank you for the opportunity to testify before you today on the National Aeronautics and Space (NAS) Act of 1958. We need to ask ourselves two questions as we review the act: how do we recommit ourselves to the policy principles set forth in the act? And where has the act proven inadequate to meet the evolving space program? We conduct yearly reviews of the National Aeronautics and Space Administration's (NASA) programs in our committee. But programs do not make policy. As members of this committee, we have a unique responsibility to take the long range view for science and space. It was this long range vision that provided the framework for the NAS Act twenty-five years ago We need to take a look at these long range questions again; we are in the midst of a "space revolution," and I am concerned that we in government have taken too short-term a view of our role.

Institutional Structures

As we consider the issues, we need to keep in mind that the space program is much bigger than it was twenty-five years ago, and that there is more and more overlap of space technology with many sectors of society; communications, military applications, and international relations are just a few examples of areas that have grown in importance since the 1958 act. This makes our review of space policy that much more complex. To help us, I recommend joint congressional committee reviews of space programs and policy formulation in these areas of overlap. We cannot afford to isolate ourselves in the midst of a "space revolution" or the space debate will proceed without our input. If we allow this to happen, our committee review could become obsolete and ineffectual.

For example, I strongly encourage joint hearings with the Armed Services Committee, or the Foreign Affairs Committee, or joint hearings with the Senate to elevate visibility and discussion of space policy and program issues. The NAS Act calls for the separation of civilian and military activities, for example. Civilian and military policy comes together in the office of the President, but I think in the Congress we are not well prepared to address military/civilian coordination and/or conflicts. We may not all agree on the issues, but we certainly have a responsibility to work together toward some consensus.

I also recommend that a new civilian Senior Interagency Group (SIG) on Space be formed as a counterpart to the currently established SIG on Space chaired by the President's National Security Advisor. This approach, or the co-chairing by the NASA Administrator of the current SIG on Space, would help to ensure a stronger voice for civilian space programs and balance the heavy military emphasis that has developed.

Space science, space applications, military/civilian activities, commercialization, NASA space operations responsibilities, and international cooperation are areas that have come increasingly under budget and policy debate and which have challenged the policy principles set forth in the NAS Act. I would like to discuss each of these briefly.

Space Science and the SSEC recommendations

Space science, although funded at an historic low, is in better shape than it has been in the past few years. This is a result of the excellent work of the Solar System Exploration Committee (SSEC). Rumors of the demise of the planetary exploration program by the Administration prompted the formation of the SSEC as an ad hoc group of the NASA Advisory Committee. The SSEC planned a coherent, long-range solar system exploration program with scientific merit that can be performed on a comparatively low budget. A "core" program for exploration of the solar system was devised that can be supported through times of constrained budgets. A expanded study is being conducted to develop the outlines of a program to accommodate future increases in funding. In any case, the SSEC's recommendations need to be supported with adequate funds.

The SSEC study could serve as a model for planning in other areas of space activities; it contains many of the ingredients for the establishment of a successful program--scientists directly involved in the field and performing the research contributed to the study; the planning was long range in nature while building on current programs, and funding is projected at stable, reasonable levels which protect high quality scientific results. NASA conducts similar exercises in other areas, and is involved in a space commercialization study currently. My praise for this approach falls short of 100% endorsement because of my belief that NASA ought to be getting advice from a more independent source. The SSEC, as I mentioned, is part of the NASA Advisory Committee, an internal NASA organization. The statutory establishment of a Space Advisory Board, responsive to both NASA and the Congress, could serve to provide more independent advice on U.S. space activities. The Space Advisory Board could be modelled after the Environmental Protection Agency's Science Advisory Board, or the Department of Energy's Energy Research Advisory Board. The Board could perform a visionary function for Congress and for NASA and help us to structure a strong and coherent space program. If we do not actively seek outside advice we will tend to make policy and base programs on a closed loop between NASA, the Hill, and special interest groups.

Space Applications and Commercialization

I am skeptical about the Administration's proposal to commercialize the U.S. land remote sensing (LANDSAT) system. It appears that the Administration is moving LANDSAT off-budget, and calling this process commercialization. A more efficient approach to promoting the applications and commercial use of space technologies developed by NASA would be to support aggressive applications, technology utilization, and technology transfer programs across the board. In agriculture, for example, application of LANDSAT technology looks promising in prediction of water supplies, inventory of natural resources and agricultural resources, prediction of agricultural soil loss, and monitoring and detection of healthy and diseased crops. NASA should be allowed and encouraged to conduct operational programs and applied research, as well as basic R&D if we hope to see LANDSAT technology, or other technologies developed through our space programs, through to the commercial stage.

NASA's Technology Utilization (TU) Office and space applications activities help promote the commercial use of technologies developed through the space program. In order to emphasize the importance of these activities and help NASA identify commercial use of technologies developed through its research programs, we could combine the TU program, space applications, and commercialization activities into a separate office of Space Applications and Commercialization. A major weakness in our space policy and programs is our inability to define and carry out the process of commercialization. We have had considerable experience in doing this with other technologies--commercial aviation and nuclear power come to mind--but we still lack a conceptual framework which allows us to take reasonable action. Combining these two functions into a separate and enhanced office of Space Applications and Commercialization, with higher visibility and greater policy attention, would be a natural step to take, and would help promote better use of space technologies. It is difficult to see how we will retain a leadership role in space without some action of this sort. NASA's space science work would then be centered in a separate Office of Space Science. This approach would benefit space science, by separately emphasizing the importance of planetary exploration, physics, and astronomy.

Military/Civilian Cooperation in Space

The erosion of the distinction between military and civilian activities in space is contributing to the reversal of the tradition of openness which characterized the first twenty-five years of the U.S. space program. The military's yearly space budget now exceeds NASA's entire budget. Analyses of NASA's budget indicate that 25% or more can be attributed to military activites (this is largely due to the space shuttle program). We are only beginning to grapple with the scientific, international and economic implications of this drift toward the "militarization" of space. The civilian program can benefit greatly from military programs, and already has. But the NAS Act calls for separate, although coordinated, civilian and military programs. What are the costs, and what are the benefits of cooperation between the two sectors? Mr. Chairman, some may want to see NASA become a support agency for the military. Some may want no interaction at all, although I know of no strong opposition to cooperation on some levels with the military. Regardless of the individual beliefs we hold, we cannot afford to ignore military and civilian interaction and conflict in space or we will surely deal ourselves out of a major emerging policy debate.

International Activities in Space

Finally, I would like to address international cooperation in space. We have tended to cut back on these activities when budgets are tight, or when we get nervous about technology transfer to other nations. My view is that international cooperation serves many functions and is important to support; political, scientific, and economic benefits can be derived from international cooperation. On the political level, we increase goodwill and national prestige by cooperating with other countries on projects. At the UNISPACE '82 Conference I attended in Vienna in August 1982, I was struck by the resentment and resistance of some nations, particularly third-world countries, to the U.S. presence in space. Space is perceived to be the realm of the U.S. military, particularly since the advent of the space shuttle. International cooperation can help alleviate some of this concern. On the scientific front, cooperation provides substantial benefits. Although it is tempting to eliminate international cooperation during times of budgetary stringency, in addition to the bad feelings generated by cancellation of programs, the leveraging of dollars is lost.

Mr. Chairman, I conclude that the NAS Act is basically sound, but that we need farsighted policy to make it effective and a consistent budgetary approach to make the act work. I encourage this committee to take a comprehensive look at the space program, jointly with other committees where appropriate, and help devise an aggressive approach in support of space science, space applications and commercialization, international cooperation, and at the very least an equitable distribution of work and transfer of technology between the civilian and military space programs.

Mr. Chairman, thank you again for inviting me to testify before you today.

Mr. **Volkmer**. Thank you very much, Congressman Brown.

We will now proceed with questioning under the 5-minute rule. Does the gentleman from Virginia have any questions?

Mr. **Bateman**. Thank you, Mr. Chairman.

Congressman Brown, in your remarks you make reference to the civilian Senior Interagency Group on Space being formed as a counterpart to the current SIG. Do you contemplate that one would supplant the other or that there should be one that is more responsive to us but both functions?

Mr. **Brown**. At the present time I contemplate that there would be two, a civilian and a military, although in the long run I am not sure that that is the most desirable. I would prefer one that is properly balanced and includes strong voice from the civilian program.

I have not observed that the system that we have has operated effectively. The SIG was originally chaired by Dr. Press in the past administration, and I suspect the military felt that Dr. Press didn't give as much attention to their concerns as they would have liked. Dr. Press was not particularly expert in space matters, although he was a distinguished scientist and very capable.

In the present circumstances, where we have a military man serving as head of the SIG, I don't feel comfortable with it. I think the civilian program is being shorted. I am not sure that we can resolve that, but that is the situation as I see it. I am suggesting that we maybe keep them separate and have a strong policy group responsible in each area, with close coordination between the two.

Mr. **Bateman**. Well, I would certainly endorse the notion that we don't want to minimize the civilian space program and sacrifice it in an unjustified or unwarranted way to a national defense effort. I suspect we would both agree that one should not be sacrificed to the other and we perhaps do need some vehicle to see that they are kept in a proper balance and perspective.

Mr. **Brown**. Mr. Bateman, if I may be allowed to say so, I have fully supported the military utilization of space. I know—I recognize that the space program owes its existence to the military, and I want to see the military make the fullest possible use of it.

I am a little leery, as you well know, about the strong trend now toward making space a military battleground, putting weapons into space. I am not sure that I see that as constructive action. I am willing to have it fully and fairly debated as to what the national interest really is, but I think we—it needs a closer scrutiny than we have given it up to the present time.

Mr. **Bateman**. Well, may I say that this member is not in the position to launch that debate today because I am not sure where this member ought to stand with reference to that debate.

I think we can all agree that it is unfortunate if it be a national security necessity, that we get more deeply involved in the militarization of space. All of us can agree it is unfortunate. We will each have to, I guess, make judgments as to whether or not it is an unfortunate necessity.

The other question that I have, Mr. Chairman, and very briefly, under the international activities in space make reference to Third World countries having a perception that our space activities are predominantly military and that this perception is heightened by the space shuttle.

I am not sure I understand that in terms of my understanding that the space shuttle and most of the payload relate not to military purposes but to civilian scientific research and projects, and including some international research and projects.

Could you comment on that?

Mr. **Brown**. Well, this is a subject that has been subjected to a great deal of propaganda. As you know, our space program is not as militarily oriented as the Soviets are. However, the Soviets have never pretended to make a distinction and nobody expects them to make a distinction, whereas we have.

What we are being hung up on now is the fact that we have made a distinction and some people are beginning to be a little distrustful, and the Third World is particularly paranoid about these things; distrustful that our so-called civilian program may be becoming a front for the military.

And of course they perceive the shuttle in—at least in part, in the propagandistic terms that the Soviets paint it, and the Soviets paint it as at least potentially a weapon because it is capable of maneuvering, it is capable of approaching and taking action with regard to satellites in space.

And while you and I know that that has nothing—that that is not remotely connected with its mission, some more suspicious person who is overly exposed to the different propaganda, as many in the Third World are, would construe it that way. I think we have an obligation to present the facts, to correct that.

Mr. **Bateman**. I would quite enthusiastically concur with the fact that we do have the responsibility to perhaps get the accurate message out there as to what we are and are not doing.

I think perhaps by this record, if anyone ever bothers to read it, our concurrence that the perception of many nations, especially Third World nations, and certainly especially the Soviet Union, and the reality are not one and the same.

Thank you, Mr. Chairman.

Mr. **Volkmer**. Thank you, the gentleman from Virginia.

The gentleman from Texas have any questions?

Mr. **Andrews**. Thank you, Mr. Chairman.

I am just wondering if you would comment on what was the old civilian military liaison board that was in the 1958 act and then it was abolished in 1965. I wonder if you are familiar with that. You were probably here then.

Mr. **Brown**. Well, I am familiar with it as a historical fact. That happens to be the year I came on the committee, and I have had no actual experience with it and I don't think I could make any comment that would yield any useful information to the committee.

Mr. **Andrews**. Whether or not we need to reestablish that kind of vehicle or not?

Mr. **Brown**. Yes; it is that kind of an approach that I am suggesting through the two SIG's, but I would have difficulty in comparing my suggestion with how that actually operated because I don't have that much detailed information about it.

Mr. **Andrews**. Mr. Brown, I know and all of us on the committee know of your interest in commercialization and your enthusiasm.

One question. If NASA is given explicit responsibilities to operate space vehicles and promote commercialization, what would these changes mean for NASA's R&D mission? Do you see such changes as weakening or strengthening to the R&D mission?

Mr. **Brown**. It would be my hope that it would strengthen the R&D mission and make the whole program more rational. I see the space program, of course, as representing a continuum from its support and encouragement and facilitating of basic research in the sciences, which has a very high priority with me, through the development of whole new ranges of commercially important industry at the other end.

I perceive the NASA role is providing guidance and policy direction for a process here, from the development of the new knowledge to its exploitation. I don't think that at any point you can consider that this is an automatic process.

The successes that we have had in the past, which I give—pay tribute to NASA for I think have been, to some degree, at least, accidental. I would like to learn from the good that we have done in the past, or the bad, to improve on our performance of developing this process from new knowledge to commercialization that is of value to our U.S. economy and, of course, valuable to the whole population of the world, which we concede the space program to be.

Now, some people—this same debate is going to take place in the wider area of industrial policy as a whole. Space policy is a microcosm of industrial policy, and I think that we can demonstrate how publicly funded research that would not otherwise be done can maximize its contribution to the public welfare in this country by giving it wise guidance in the space program and showing how this would be applicable to other areas where publicly supported research contributes to new, potentially commercial developments.

Mr. **Andrews**. Thank you, Mr. Brown.

Thank you, Mr. Chairman.

Mr. **Volkmer**. The gentleman from New Mexico?

Mr. **Lujan**. Thank you, Mr. Chairman.

George, I would like to follow up a little bit on this civilian and defense applications of space research.

We have a pretty good example in the DOE where both the civilian programs are under its jurisdiction and the defense programs. I have been impressed with how they contribute to one another. You mention that—the larger funding in the Department of Defense space activities, then in the civilian activities. And that is pretty much the same in the Department of Energy.

What would you think of following that example in our space program, having defense policies division to NASA, NASA being responsible for the research in civilian space activities and in defense space activities?

Mr. **Brown**. I think that is an excellent model which could be followed up to a point. At a point, you know, even in the Department of Energy control over nuclear, it hands off the product to the Defense Department and the Defense Department takes over.

We would have to do the same thing in the space program at the point where we—NASA would hand off a new vehicle, for example, that had military application or where a new weapon, such as this

ASAT, was developed. Then it would come under the jurisdiction of the military.

But in my opinion, I think we could benefit from following the model of the Department of Energy on a much broader range of the research and development activities than we are doing today with the bifurcated program.

As you know, Defense Department has its own space R&D, a very large space R&D program. At the R&D stage, I see no reason why we couldn't handle it, just as Energy handles R&D in the nuclear. I think it would give us a better handle on the thing and a clear distinction between the civilian and the military aspects.

Mr. LUJAN. And there is a cross-benefit to some of the research—some of the advancements that result—that come as a result of weapons research are then applied to the energy research. We have the same thing thing in NASA in the aeronautical research——

Mr. BROWN. Precisely the same.

Mr. LUJAN [continuing]. So that it would—it might fit.

Mr. BROWN. To take an example which is the subject of some debate right now in terms of the commercialization, as you well know, we have two major Earth reconnaissance programs. One is the military intelligence program and the other is the far cruder Landsat program. They are conducted separately.

I have inquired as to the degree of interaction between the two programs, and to the—and I don't pretend to have a broad base of information, but I have been told that sometimes the same company may be working in both programs and they can't communicate internally within the same company. That may not be as accurate, but I would consider it regrettable, if that is the situation. I would understand it, but I would consider it regrettable.

Mr. LUJAN. We are—we look at the positioning of aircraft and now we are talking about using it for civilian aircraft and for civilian maritime. Why can't we do the whole thing under one program? It would seem to me to be logical.

Mr. BROWN. Very comparable situations. The global satellite positioning system has immense commercial application to all forms of sea and air transportation. I am told that up until recently, at least, it was not possible for civilian aircraft to acquire the more refined military system, which it would need and which would have prevented the Korean Air Lines thing, if it had been in effect.

Mr. LUJAN. On to another subject, and that is the whole area of commercialization, how far do you think we ought to go? To the point where we have TWA, United—I ought to mention all the airlines—running a space shuttle back and forth to a space station, making it a totally civilian airline going into space and back?

Mr. BROWN. I think that there is no real limit on civilian operations in space, including the operation of several different independent space transportation systems, the operation of large-scale commercial activities, such as industrial manufacturing or—I see no reason why the global satellite positioning system couldn't be operated by civilian contractors, just like the Kennedy launch site is or various other things that you could name, with suitable protections, of course, for the national security needs.

My concern, Manny, as I am sure it is with yours, is that we set the system up in such a fashion that either because of the nature of the contract or because of the existence of full and free competition, that we avoid the possible dangers of monopoly control by private sector enterprise in which neither the public interest or free competition is protected.

Mr. **LUJAN**. But don't you think as we move in the direction that we are in the airline industry today, of cities operated airports or launch pads, whatever you want to call them, and we will come to just an airport operation of the shuttle eventually? There is several different airlines. There is private Lear shuttles in the future, I suppose, for one company that has sufficient work to do in space. You would avoid that monopoly. The private enterprise system would clearly take care of that.

Mr. **BROWN**. As far as I am concerned, it is wide open for exploitation, with the private sector carrying the bulk of the load there and the Government setting the rules, basically, as we do here on Earth.

Mr. **LUJAN**. Thank you, Mr. Chairman.

Mr. **VOLKMER**. I have one little question. As I understand your statement in regard to advisory councils, you would recommend that we have a more independent advisory council rather than one within the system itself?

Mr. **BROWN**. Correct.

Mr. **VOLKMER**. Similar to science——

Mr. **BROWN**. Yes, I compared it with the EPA and some of the other agencies.

Mr. **VOLKMER**. And do you think that NASA should get more into operational programs or is that where we are?

Mr. **BROWN**. I think that NASA should clearly have the option of operating a program—you could refer to it, I suppose, as a commercial demonstration—but operating it as a commercial program up to the point where there is a clearly defined market or other arrangement which will allow it to move under reasonable conditions to the private sector. I don't want it to be precluded from conducting a commercial operation up to a point, with the clear understanding that that is not a permanent role, but that is a transitional role.

Mr. **VOLKMER**. But then permanency would still be maintained as far as R&D is concerned?

Mr. **BROWN**. Yes.

Mr. **VOLKMER**. I have no further questions.

Does the gentleman from California have any questions?

Mr. **DYMALLY**. None at this time. Thank you, Mr. Chairman.

Mr. **VOLKMER**. I wish to thank Congressman Brown for his very helpful information. I know his interest in the matter. We will continue to work with him as we go through the question of whether we need to amend the Space Act itself.

The next witness will be Mr. Daniel J. Fink, Chairman of the NASA Advisory Council.

Mr. Fink, I welcome you here this afternoon, and your statement will be made a part of the record, and you may either review your statement in full or summarize, however you so desire.

You may proceed.

STATEMENT OF DANIEL J. FINK, CHAIRMAN, NASA ADVISORY COUNCIL

Mr. FINK. Thank you, Mr. Chairman. I will read my statement, but I will shorten it in a few places in the interest of time.

I very much appreciate the opportunity to appear before you on behalf of the NASA Advisory Council as you conduct your review of the 1958 Space Act. It is timely that our council has just completed a study of the long-range missions of NASA and submitted its file report to the Administrator. My testimony will be largely based on this effort. Copies of the full report on this study have been made available to you today.

As you may know, the council was established to advise the NASA Administrator on the Agency's aeronautics and space programs and to provide guidance on policy and strategies for their achievement. Issues are addressed at the request of the Administrator or his direct staff or are initiated by the Council. At its March 1982 meeting, the Council proposed and the Administrator approved that a study of the mission of NASA be undertaken by a Council task force.

The Council believed that such a study would be timely because in recent decades a single major project, such as Apollo or the shuttle, has tended to drive and focus NASA's goals and objectives.

As you said in your introduction, Mr. Chairman, the shuttle is nearing the completion of its development phase. Furthermore, NASA now has a very large technical base from which to make choices, while other agencies, nations and the private sector are involved in space enterprises to a degree not foreseen by the National Aeronautics and Space Act of 1958.

It is, of course, that historical piece of legislation which is the central theme of your hearings. In undertaking to study the NASA mission in long-range terms, there was the implicit question of the adequacy of the Space Act to respond fully to future needs and challenges.

I say implicit because in our charter the Space Act served as a reference and we were not seeking changes. On the other hand, the task force was very alert to statements in the act which would have prohibited or even inhibited the relationships or directions that they felt NASA should be taking.

While I have not polled the members of the task force on this subject, I think it is safe to say that we all feel the 1958 Space Act is a remarkable piece of legislation that has stood the test of time in a time of phenomenal change.

At no time in our deliberations did we find the Space Act to be inhibiting in considering future missions, nor did it suggest responsibilities that should not or could not be fulfilled. It remains today a strong guide with respect to national purpose and policy in aeronautics and space and the basis for the missions of NASA.

I would like now to discuss some of the specific areas covered in the mission of NASA study in which you, Mr. Chairman, have expressed particular interest. These include NASA's future mission in STS operations, the NASA/DOD relationship, NASA's space science and applications activities, some aspects of commercialization of space, and the international impact of these and other of

NASA's aerospace efforts. I will close with a summary of the mission statement that we believe should guide NASA activities as we approach the next century.

One of the important issues addressed by our task force dealt with management options for operating the Space Transportation System. Concerns were expressed as to whether the current embedded management approach would create a serious diversion of NASA resources and attention from its fundamental role in aeronautics and space R&D and exploration.

Questions have been raised as to whether NASA, or any Government agency, can achieve the operating efficiencies, levels of customer satisfaction, or degree of market development desired.

The task force examined various options for managing STS operations, including commercial, DOD, and new agencies. The group concluded that in light of the present small size of the shuttle fleet, the high cost of operations, and other factors, shuttle operations should remain within NASA.

However, the report does recommend that a new NASA organization be created to manage shuttle operations and utilization and that within this new NASA entity manpower, finances and facilities be fenced or confined to serve only these objectives. This shuttle operations organization would be responsible for marketing and sustaining engineering support but not for future development activities.

The task force also concluded that the value of the STS as a national resource, due to its unique capabilities to support a number of important national objectives, was of special significance. It recommends that in determining launch and service pricing for STS users NASA should make allowance for the national resource character of the STS and consider shifting toward an incremental or institutional cost basis, rather than on a basis of full recovery of recurring costs.

NASA's programs and activities in space science have been and continue to be of major importance to NASA and our Nation. The task force, in its approach to space science, chose to view the subject in two parts: Space science conducted to contribute to human welfare and national needs, and fundamental space science conducted to expand human knowledge. I would like to defer my remarks on the first until later in this presentation in order to highlight it properly.

In the fundamental sciences, the study recommends that adequate and stable levels of funding be provided for supporting ground-based research independently of the fluctuating needs for construction of spacecraft. It further recognizes that other agencies are involved in many science programs in which space plays a part.

NASA is sometimes reluctant to take a leadership position, but strong leadership is required to make such programs a success. The task force recommends that, when appropriate, NASA take the lead in seeing that such programs are properly coordinated. It is imperative that space science, now a central element of scientific research in the United States, remain a principal part of NASA's mission.

Historically, NASA has not established a clearly defined mission in space applications. The NASA role has changed over time and has been quite different for each of the major applications areas: Telecommunications, meteorology, Earth resources and materials processing in space.

The task force recommends that NASA continue to identify possible civilian applications of space operations; that early on they involve the appropriate users and providers of service in identifying requirements and priorities for the programs; that they conduct the research and technology development required for civilian space applications that cannot reasonably be conducted and funded by the using agencies; and that when suitable cooperative arrangements are made, they provide the utility demonstration and experimental operation of such space systems.

The task force did not address the NASA/DOD relationship as a policy issue but made recommendations, as appropriate, in its reviews of the STS operations, aeronautics, and space technology mission areas.

Summarizing, the aeronautics relationship works well and is completely consistent with the Space Act. Coordinating activities should continue at both the top management and working levels. In space technology, NASA's role should evolve to comparability with its role in aeronautics; namely, it should be supportive of total national requirements, not just agency needs.

The question of commercialization of space was the subject of the hearings of this subcommittee last May. Our mission of NASA study did not consider this subject in its own right but did give some attention to commercialization of STS operations.

As I noted earlier, we believe that the STS is not yet ready for that step. NASA itself has the many aspects of commercialization under study and has asked our council to advise on this matter. Our efforts in this are just beginning. As a matter of fact, we have a 2-day meeting going on right now on this subject.

The Space Act, as you know, has promoted international cooperative activities in space, as have most of the national space policy statements since that time. With this in mind, the task force reviewed and examined the international aspects of NASA's role and missions and agreed that these activities are important to the maintenance of the image of the United States as the technological leader of the world. There was some concern expressed that the value of NASA's activities is sometimes misunderstood or not fully appreciated within the Government.

Another finding is the need for stronger and more binding commitments in cooperative ventures with other nations. It questions whether U.S. policy on technology transfer is not counterproductive in limiting the ability of foreign nations to procure American space products rather than having to develop such products domestically.

The study recommends that NASA take action to increase awareness within the U.S. Government of the value of aerospace programs as instruments of foreign policy and that future cooperative agreements by NASA with other nations and/or international organizations be consistent with our national long-range foreign policy objectives and achieve a greater degree of stability.

Earlier in this testimony I pointed out that in the past NASA's goals and objectives were largely driven by major single projects.

The question naturally arose before our group as to whether another major project effort should again assume that role. We concluded that space is now involved in so many aspects of our national pursuits that NASA should have multiple missions.

There is, however, one area which NASA uniquely has the charter and skills to pursue; namely, the exploration of the solar system; exploration not just for scientific understanding, which remains a cultural goal of high priority, but with an eye toward ultimately extending the human presence into new environments and using the material and energetic resources of the solar system for the benefit of humanity.

This mission of NASA involves two parts: One, exploration of the solar system with the eventual goal of utilizing the resources and knowledge of space for human benefit; and two, examining our own planet from a planetary perspective, one that will provide greater and fuller understanding of the processes involved in global surface and atmospheric changes important to living systems.

For the achievement of this long-range effort, the study group recommends NASA's leadership and vigorous pursuit of such exploration in collaboration with other interested nations.

Recommendations also call for adequate funding to pursue the necessary technologies and conduct the ground-based and supporting research to achieve these long-range objectives and, most important, a shift from the project-to-project approach of the past to planning and budgetary policies appropriate to a lasting national commitment of this nature.

Those who participated in the deliberations on the Mission of NASA concluded their efforts with a statement that represents their consensus of that mission. It is brief and, if I may, I would like to read it to you:

> Mankind has acquired the ability to move within and beyond the confines of the surface and the atmosphere of Earth, creating apparently limitless opportunities for beneficial human activity. In this regard, NASA has a dual mission—in space and the atmosphere—portions of which are overlapping.
>
> NASA's space mission is to conduct activities on behalf of the people of the United States in collaboration with other nations to:
>
> First, explore the solar system and study its planetary processes, including, as appropriate, those governing the Earth, for the benefit of mankind;
>
> Second, pursue a program of fundamental scientific research in space to expand human knowledge;
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> Third, plan and implement space technology programs and research into the use of the environment of space in order to provide for the continued advance of the national space capability and its exploitation for public and commercial purposes;
>
> and to achieve these ends, create the capability for an expanded human presence in space and develop and assure the operation of launch and space vehicles.
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>
> Although it may not now be productive to debate the specific nature or the timing of this most dramatic of all human ventures, it is appropriate to use such a venture as a distant goal to guide our search for an understanding of the solar system and to stimulate the further advance of humankind.

Thank you.

[The prepared statement of Mr. Fink follows:]

STATEMENT OF DANIEL J. FINK, CHAIRMAN, NASA ADVISORY COUNCIL BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS, COMMITTEE ON SCIENCE AND TECHNOLOGY, HOUSE OF REPRESENTATIVES

Mr. Chairman and Members of the Subcommittee: I appreciate this opportunity to appear before you on behalf of the NASA Advisory Council as you conduct your review of the 1958 Space Act. It is timely that our Council has just completed a study of the long-range mission of NASA and submitted its final report to the Administrator. My testimony will be largely based on this effort; copies of the full report on this study will be available to you today.

As you may know, the Council was established to advise the NASA Administrator on the Agency's aeronautics and space programs and to provide guidance on policy and strategies for their achievement. Issues are addressed at the request of the Administrator or his direct staff or are initiated by the Council. At its March 1982 meeting, the Council proposed and the Administrator approved that a study of the "Mission of NASA" be undertaken by a Council task force.

The Council believed that such a study would be timely because in recent decades a single major project (e.g., Apollo, Shuttle) has tended to drive and focus NASA's goals and objectives. The Shuttle is nearing the completion of its development phase. Furthermore, NASA now has a very large technical base from which to make choices; while other agencies, nations, and the private sector are involved in space enterprises to a degree not foreseen by the National Aeronautics and Space Act of 1958.

It is, of course, that historical piece of legislation which is the central theme of your Hearings. In undertaking to study the NASA mission in long-range terms, there was the implicit question of the adequacy of the Space Act, as amended, to respond fully to future needs and challenges. I say "implicit" because in our charter the Space Act served as a reference and we were not seeking changes. On the other hand, the Task Force was very alert to statements in the Act which would have prohibited or even inhibited the relationships or directions that they felt NASA should be taking.

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I would like now to discuss some of the specific areas covered in the Mission of NASA study in which you, Mr. Chairman, have expressed particular interest. These include NASA's future mission in STS operations, the NASA-DOD relationship, NASA's space science and applications activities, some aspects of commercialization of space, and the international impact of these and other of NASA's aerospace efforts. I will close with a summary of the mission statement that we believe should guide NASA activities as we approach the next century.

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The Task Force also concluded that the value of the STS as a national resource, due to its unique capabilities to support a number of important national objectives, was of special significance. It recommends that, in determining launch and service pricing for STS users, NASA should make allowance for the national resource character of the STS and consider shifting towards an incremental, or institutional, cost basis, rather than on a basis of full recovery of recurring costs.

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"First, explore the solar system and study its planetary processes, including, as appropriate, those governing the Earth, for the benefit of humankind

"Second, pursue a program of fundamental scientific research in space to expand human knowledge

"Third, plan and implement space technology programs and research into the use of the environment of space in order to provide for the continued advance of the national space capability and its exploitation for public and commercial purposes

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Thank you for you attention.

DANIEL J. FINK

Daniel J. Fink is President of D. J. Fink Associates, Inc., which he established in 1982 to provide management consulting on corporate and business strategy in high technology industries. Much of his earlier career was with the General Electric Company in their aerospace operations, rising to the position of Vice President and Group Executive, Aerospace Group, and then to Senior Vice President, Corporate Planning and Development. He has served in the Department of Defense as Deputy Director of Defense Research and Engineering; his early career included engineering and management positions with Bell Aircraft Corporation and Allied Research Associates, Inc. In addition to being chairman of the NASA Advisory Council, he is a member and past chairman of the Space Applications Board of the National Research Council, was a member of and is now senior consultant to the Defense Science Board, and serves on the DIA Advisory Panel. He has been awarded the Collier Trophy and the DOD Distinguished Public Service Medal, and is also an Honorary Fellow and Past President, American Institute of Aeronautics and Astronautics. He is a graduate of the Massachusetts Institute of Technology, receiving BS (1948) and MS (1949) degrees.

[The "Mission of NASA" study is included as appendix 2.]

Mr. VOLKMER. Thank you very much, Mr. Fink.

We will now proceed with questions under the 5-minute rule.

The gentleman from New Mexico have any questions?

Mr. LUJAN. Thank you, Mr. Chairman. Just a couple of quick questions.

Was it by design or just after discussion within the group that you chose not to address the defense aspects of space? It seems to me it is quite an important component of our entire space effort, and the board did not go into it. Is there some particular reason why you didn't?

Mr. FINK. Not really. We didn't see it, let's say, as a mission of NASA. On the other hand, it really is discussed in almost every section; in other words, it is discussed in the STS operations, in space technology, and in the aeronautics sections. So I think there is an ample discussion of that relationship when it affects a mission.

Mr. LUJAN. The—certainly in aeronautics you are very straightforward about saying that whatever it takes, that the research that needs to be done is to increase our position in the aeronautical field both in civilian and defense requirements, but you do not make that straightforward a statement in the others.

You were in the room when I was asking Congressman Brown about a DOE type of arrangement where NASA is responsible for all space work, the same as we are in aeronautical research. Can you give us your thoughts on that?

Mr. **Fink**. Yes. There were—I think I will speak on behalf of the Council. There is a difference between the space side and the aeronautic side. NASA has a very long history, of course, going back to the NACA days, in supporting aeronautics. They built up over the years some very unique facilities, people, which are not duplicated anyplace else.

In space, the evolution has been different. The facts are, as has been stated in this room, that the military has a very large program, that there is a large commercial endeavor already, that the facilities are spread throughout not just NASA, but within aerospace companies, the military and so forth. So, you don't have the same uniqueness.

And so what has happened is that NASA in its space activities, when they started their program they supported their own activities; in other words, they had certain missions and projects that they were interested in. Their technology supported those projects.

We now recommend that they start moving from that and really support national objectives consciously, which means that they do move in the direction that I think you are taking, where they do support more fully military space activities, as well as future requirements of the commercial sector. But it is going to take some time because they do start from a different point.

Mr. **Lujan**. Is there a duplication between what we have in NASA and the facility that is now in the progress of being built at Vandenberg? Is there a lot of duplication there? Is it really necessary, or are we doing that just because the military wants to have their own installation rather than doing it out of Cape Canaveral or——

Mr. **Fink**. No; that one I think is very clearly differentiated and pretty well coordinated. The Vandenberg facility is designed to launch the shuttle in the north-south direction, something which cannot be done directly from Cape Canaveral. Cape Canaveral launches primarily to the east. So, it is——

Mr. **Lujan**. And NASA has no interest in that kind of an orbit?

Mr. **Fink**. Oh, yes; and the Vandenberg facility will not just launch military payloads, it will launch any payload, civilian or military, which wants to go into a north-south orbit, which merely means all those which observe the Earth for meteorological purposes, Earth resources or any others. So, I think that—Mr. Lujan, is very clearly justified.

Mr. **Lujan**. It should not have been under NASA, then, you think?

Mr. **Fink**. I guess it could have been, but I think the partnership works well.

Mr. **Lujan**. Let me get on to the subject of STS. You say that eventually it should be commercialized but not at the moment. Is that—did I understand that correctly from your testimony?

Mr. **Fink**. The eventually is not that clearly stated in the report. There are indications that perhaps it could be eventually, but it was hard for the group to see out that far. The group does believe, though, that the initial step they take will make it easier to ultimately do that.

Mr. LUJAN. Is that because the—by commercializing it it couldn't carry its own weight right now? Is that the reason?

Mr. FINK. That is right. That is exactly right.

Mr. LUJAN. Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you.

The gentleman from California, Mr. Brown, have any questions? Do you have any questions?

Mr. BROWN. Did you say Brown or Dymally? Let me ask just one question, if I may.

Mr. Fink, I was pleased with the overall tone of the study. I think it is very constructive. I noted the emphasis you put on coordination between NASA and the National Science Foundation, for example.

I was unaware that there might be some problems there, although I can see how it might be developed. I just haven't been that close to it. Of course, I was putting some emphasis in my own statement on closer coordination on the civilian and military aspects, which I think are equally important, but that is not what I wanted to ask you about.

I have been concerned about the possibility within a suitable political environment for enhancing the development of space much more rapidly through the continued establishment of international systems in space, not just bilateral cooperation or cooperation with European Space Agency, but more the model of Intelsat, which is a truly global, international system and which I think was a key to the rapid development of global communications.

Could I ask you to comment on whether or not you see the possibility, aside from I think some obvious political considerations, the possibility that moving in this direction to establish international institutional systems might be a way of facilitating and sharing the cost of space development, expediting it in various different areas?

Mr. FINK. I will try. I think philosophically for sure, and in part practically, international space endeavors are a very good idea. NASA certainly has used international cooperation in the shuttle, for example, have in Canada, with the ARM, and ESA Space Lab and so forth, which made it an international endeavor.

When we talk about the planetary program that we envision, ultimately that program could reach a size where again an international program might be the best way to proceed.

On the other hand, as someone who has spent considerable time in industry, the facts are that they are very complex. They are tough to manage, extremely tough to manage. Political activities can often interfere what would otherwise be straightforward technological judgments and, therefore, I would have to urge caution on any strong push to international activities. It could inhibit as well as encourage the expansion of space which you desire.

Mr. BROWN. Had you—have you seen any signs that Intelsat has inhibited the development of global satellite——

Mr. FINK. No; I think Intelsat served its purpose very well. On the other hand, Intelsat and Comsat was not always looked on with great benevolence by all international bodies and countries, and there have been and continue to be strong pushes to have regional activities, national activities, which are now all coming up against Intelsat.

So while it certainly served the initial purpose, it's being attacked.

Mr. **Brown**. Thank you.

Mr. **Volkmer**. Thank you.

I now recognize the gentleman from Texas, Mr. Andrews.

Mr. **Andrews**. I don't have any questions, Mr. Chairman, at this time.

Mr. **Volkmer**. The gentleman from California?

Mr. **Dymally**. Thank you, Mr. Chairman.

Mr. Fink, the gentleman from New Mexico made note of the fact that you chose not to deal with the question of defense because I suspect it is in another area. I note the omission of the university involvement. Were you also saying I don't want to get involved with what NSF is doing? You have international relationships, but I did not note any university connection in your report.

Mr. **Fink**. You are quite right, Mr. Dymally. That may have been an oversight on our part because I think that our group would strongly support NASA's activities with the universities. It, of course, is implicit in the kind of strong science program that we've talked about, but we did not, you are quite right, address it as a separate issue, and perhaps we should have.

Mr. **Dymally**. Good. One more question.

Do you think that in the original act that NASA was given enough flexibility to deal with the involvement of minorities in NASA? That has become a concern of theirs, more so now than maybe 1958. Do you think the legislation needs to be strengthened or that they ought to be given flexibility—more flexibility to deal with that, or do they have it now?

Mr. **Fink**. While we didn't look at that directly, I am just always amazed at the flexibility of the Space Act and what it has permitted NASA to do, so I really believe that it—that would apply to your question as well.

Mr. **Dymally**. In recent discussions with NASA I get the impression and satisfaction that they are becoming very sensitive about this and plan to, in the next proposal before Congress, to ask for some flexibility in the language in the authorization bill to do some more experimentation with minority universities and colleges, so I take it from that that they have, but they still would like to get not necessarily statutory permission but some sort of congressional expression of support for that interest.

Thank you very much, Mr. Chairman.

Mr. **Volkmer**. Thank you.

The gentleman from Pennsylvania?

Mr. **Walker**. Thank you, Mr. Chairman.

I notice from your testimony that you are just beginning now to take a broad look at the commercialization aspects in space. Have you looked at it far enough to conclude that commercialization will play a major role in space activities over the next 25 years?

Mr. **Fink**. I certainly hope that it will, Mr. Walker. People often have a different definition of what they mean by commercialization.

Mr. **Walker**. Well, from my standpoint I guess what I am basically saying is industrialization. When I use the term commercialization, I go beyond commercializing shuttle launches and so on. I think probably I am moving more toward the area of industrialization.

And what interested me in your comments was your comment toward the end of your testimony, that you said that human habitation of outer space is likely to be more significant than is now contemplated. I am wondering if you base that on some projection that there will be increased human activity in outer space as a result of commercialization and/or industrialization.

Mr. **Fink**. In all honesty, that comment is made not just because of more activity in commercialization, but just also for the feeling that the human presence for more ambitious exploration will also be required. So, I can't honestly say that it was just for commercialization, but certainly their presence, I think, will enhance commercialization.

Mr. **Walker**. What I am leading toward here is a—an attempt to find out just where we ought to be looking at NASA, as you have done, in terms of meeting the needs of the science community, the technical community for the future, as well as inspiring the commercialization, which I think most people who look at space understand is coming.

And I start to some extent from the premise that if, in fact, you are going to have additional human habitation in space, if you are going to—whether it be through exploration or commercialization—if you are going to have increased military activity, doesn't it seem likely that at some point in outer space we are going to arrive at a Sutter's gold kind of find in terms of the exploration of the West that will really inspire a major need to have more human habitation of outer space and will really spur on much commercial development? I mean, isn't that at least likely at some point in the future?

Mr. **Fink**. All I can say is that I hope so, but right now we are at such an early stage, we are sort of, you know, just putting in the railroads and perhaps creating some of the infrastructure to let people reach that stream where Sutter found his gold.

Mr. **Walker**. Understandably, but you see, but that gets us to the question, then, of what—of what we should be doing in the Organic Act with regard to NASA because if we would arrive at that kind of time, when all of a sudden there is a major need for the—an expansion of commercial types of activities and you have assigned all of that to NASA and you have essentially made NASA the only agency involved with space, it seems to me that you could begin to peel off a great deal of NASA's budget just doing the things which are absolutely essential, given that kind of scenario, and lose all of the money that is necessary to be on the frontier of science.

I am not certain I am putting it very well, but I see us perhaps locking NASA into a role of—if it is the only commercializer—of running into major kinds of budget crunches in the future, and I am—that is the reason why I have kind of taken the position that if we are going to preserve NASA as being an agency doing good science, that one of the things we have got to do, then, is encourage NASA to spin off those things which have passed the research and development stage and gone into commercialization.

I guess what I am looking for is your comment on that kind of pattern.

Mr. **Fink**. You know, first of all, when I made my comment about the kind of commercialization, I am glad you said what you did because that is the kind that I think is important; namely, industrialization, endeavors in space which commercial entities want to do for their own purposes—to make something, to provide a service, to bring it back to Earth or whatever—as opposed to spinning off, let's say, commercializing a launch vehicle or spinning off some already developed technology.

So, if we talk about that kind of industrialization, I just think we are so far away from the world that you are worried about that I cannot see changing legislation right now.

What we have to do is make it more attractive for those commercial entities to get in there and want to use the facility. Right now they are overwhelmed by the complexity of it, they don't understand the laws, their ability to retain proprietary rights.

The group that I have assembled for this new task force is primarily composed of people from chemical, biological, pharmaceutical, electronic industries, none aerospace. It will be interesting to see what their reaction is to moving into space commercially. I think those are the people that you want to operate in space, and we have a long way to go to make them stand in line.

Mr. **Walker**. But this is the first time we have really tried to involve them in any kind of a large scale, isn't it? To some extent they are overwhelmed because up until now the whole jurisdiction in space has been a NASA jurisdiction, it has been a governmental entity, and our desire in some instances to keep it that way helps discourage people from getting involved themselves.

Mr. **Fink**. I don't think that is the issue. I really don't. I really think the issue is that if you are in a commercial entity and try to get some money from your bosses to develop the next commercial project, space seems so far away and we haven't—until the shuttle came along, there was really no easy access. I can remember looking at this years ago and trying to interest my own company, and I might as well have been talking about going to Mars. Now the shuttle is here, and the space station might not be far along, so it becomes a lot more real. There is a chance to get there.

Mr. **Walker**. But the longer you preserve the shuttle as an R&D-related item and don't move toward commercialization of the shuttle, don't you preserve exactly that kind of attitude? You—you stated earlier that you are not in favor of commercializing the shuttle at this point, and I don't think the whole system could be commercialized at this point, either. I don't think there is any likelihood of that.

But have you commented at all on the idea of allowing a commercial entity to buy the fifth shuttle, for example?

Mr. **Fink**. Not really, but—I can't—at this point I—I am no longer talking for the council. I can only talk for myself because we are looking at it.

I believe that right now the flexibility that the Space Act gives NASA to try different modes of enticing industry, getaway specials, and the kind of agreements that they are making, a private profit-making organization couldn't do.

I think we are far better right now to encourage commercialization by letting NASA take these early steps to get people involved. Then perhaps once there is some experience might be the time to commercialize the actual operation. I think it is premature now. I think NASA can probably do the best job of interesting those nonaerospace people in the use of space.

Mr. WALKER. And you don't see a role for even, say, trying it with 20 percent of the payloads?

Mr. FINK. I really can't comment. I just haven't looked at that proposal by itself.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. LUJAN. Mr. Chairman, if I may, just to follow up a little bit—and that is one of the things I was concerned about, about leaving the military out of it—in order to put a space state, for example, we are talking what are we going to do with it.

If the military have it, they can hang a couple of missiles on it and justify it. Then it is there for McDonnell Douglas to put their experiment in, or whoever—whoever else is.

That is why it seems to me so important that maybe the council ought to look at putting together the civilian and military because the military is one way to justify having it up there; not on a financial basis, but, as I say, hang a couple ICBM's on it or whatever and you are protecting yourself so it is worth $16 billion or whatever.

Then once you have it there—I was thinking, for example, Los Alamos, when the laboratory was put in there, it was put in there just for military purposes. Well, then, all of a sudden Maury Goodman came in and put in a store and Bob Dragon put in a drug store and then all of a sudden it is a civilian community but would not have been there—neither one of those two fellows would have gone over there and put in stores had it not been that it was started off by the military. That is why I think maybe we ought to have the whole thing under one, and I think we can push the technology along on the defense need basis.

Mr. FINK. I think our experience is that the military and civilian activities start out to get at the basic research, basic science levels, but they soon diverge. The military gets mission oriented, and they do their things to serve those particular missions. Whereas NASA has a much broader role in moving ahead technology. So, I am not sure that your analogy to the DOE would work in this space activity.

Mr. LUJAN. Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you.

I have a couple questions.

In your statement you recommended consistent programs for the—our planetary solar system exploration science programs continuation. Are these consistent with those that were made by the Solar System Exploration Committee of the NASA Advisory Committee earlier this year?

Mr. FINK. They are consistent, but they go considerably beyond that committee. That committee was very much concerned with a base, stable program, so this would really start there and build.

Mr. VOLKMER. All right. Now, also, you heard Congressman Brown in his testimony state that perhaps we need a more independent advisory council or board. Do you wish to comment on that?

Mr. **Fink**. I like to think that we are independent. Of course, it is true that we are established by—essentially by statute and support the—NASA. On the other hand, there is a—we really serve two purposes. Part of our activity goes back to the old NACA days, where the "C" remember, stood for committee.

And really, the committee structure that we have, particularly that which works with the parts of NASA—aeronautics, space sciences, what have you—is a tremendously powerful tool for coordination with industry and universities and the people who are playing this game. That is one purpose.

The other is these special studies that we talk about now—and I believe that we operate in a fairly independent way on these programs. This mission of NASA study was done at our initiative. We weren't asked to do it. We felt it should be done. We don't always give NASA back necessarily what they want.

Mr. **Volkmer**. It wasn't done at the request of the Administrator?

Mr. **Fink**. This particular one was not. It was approved by him, but we initiated it ourselves. Of course, the Congress does have other avenues of independence to look to. The National Research Council's activities are available for your purpose as a truly independent body.

But our membership is, remember, drawn from academia, industry, some totally outside people and I believe behaves in a very independent way.

Mr. **Volkmer**. And, too, when you went into the study of mission of NASA for the future, did the task force specifically look at the Space Act of 1958 to determine whether or not any changes would be proposed? In looking at your statement, it appears that—you say you did not poll the members of the task force on this subject.

Mr. **Fink**. We didn't start out with the idea that there was something wrong with the Space Act and we should look at it. We more or less took it as a given. On the other hand, every time that we wanted it, we had an idea to do something, we would check and make sure the Space Act didn't prevent it in any way. We just, as I said, found that really the act is a remarkable piece of legislation.

Mr. **Volkmer**. You see no inhibitions on commercialization——

Mr. **Fink**. Not really.

Mr. **Volkmer** [continuing]. Within the present framework?

Mr. **Fink**. Not really.

Mr. **Volkmer**. Now, you did mention regard to the shuttle in your report and in your testimony a new organization be created within NASA for that specifically, to fence in the money, et cetera.

Would this be an organization independent from NASA basically? In other words, would the NASA Administrator still be in charge of it or would we have a separate entity within NASA, a head of it appointed by the President, et cetera?

Mr. **Fink**. As we saw it, it would be a separate organization within NASA reporting to the Administrator. We just felt we could not separate it any further than that at this time.

Mr. **Volkmer**. It would still be under the Administrator, then?

Mr. **Fink**. Yes.

Mr. VOLKMER. All right. And do you have any idea as to when this entity should be created? Did you all discuss that? When is the shuttle operations going to be such that it is no longer R&D in any extent, it is just purely operational?

Mr. FINK. I think it will take a little time for NASA to wrestle with this, if they agree to do it. My own opinion is it should be in the near future.

Mr. VOLKMER. And then any—because I am trying to get this straight in my mind. I can see the operational part, but what I see in the future is continued evolvement of that shuttle, an evolutionary process with continued R&D.

Do you see that also?

Mr. FINK. Yes, that is one of the reasons why the thing has to remain in NASA. But again, we would have this shuttle operations organization only be responsible for the sustaining engineering and very near-term modifications. Future additions would be the responsibility of the development part of NASA.

Mr. VOLKMER. In other words, if it would—be proposed that you had such an organizational structure and it would be proposed that we change the configuration of one of the shuttles to—so it could be going into orbit, say, for instead of 9 days or so, whatever the maximum is now, to 20 or 21 days, that wouldn't be within the operational, that would be within the R&D then?

Mr. FINK. That is right. Yes, I think that would be a sufficiently major activity that it would be in the development side.

Mr. VOLKMER. All right. Now, did the council in any way during these deliberations on the separate base—entity for the operation consider using a Government corporation to do that?

Mr. FINK. They did.

Mr. VOLKMER. Was that rejected?

Mr. FINK. Pardon me?

Mr. VOLKMER. Was that rejected?

Mr. FINK. It was rejected, and I am not sure I can give you any—any detailed reason right now. As I recall it, it didn't seem to add anything to the operation. And again, the—the ties to NASA at this stage are so strong that we saw no value in a new separate entity.

Mr. VOLKMER. But you did see the possibility in the future of commercialization of the shuttle?

Mr. FINK. That is right.

Mr. VOLKMER. Not at this time but in the future?

Mr. FINK. That is right.

Mr. VOLKMER. And during your deliberations did you examine the needs for being prepared to commercialize it in that future, whether it is 10 years from now or 15 years from now?

Mr. FINK. Yes, and that is pointed out in the report as one of the responsibilities of this new organization.

Mr. VOLKMER. Do you envision in that organizational structure, and perhaps leading to eventual commercialization, involvement of the private sector?

Mr. FINK. Well, one recommendation made is that they should consider early on the private sector assisting this new organization in the marketing of the shuttle. We feel those are skills which are better drawn from the private sector than from within NASA.

Mr. VOLKMER. I haven't had time to read your report, and I plan to, but does your report—say in the missions that you see any changes from what it is presently doing?

Mr. FINK. You mean changes in what NASA does?

Mr. VOLKMER. Yes, and what it will be doing? And you say in here the study of mission of NASA. Is it a continuation basically of what they are doing now?

Mr. FINK. It is a continuation, but there are a number of specific recommendations for alternations or modifications of the way they go about it and emphasis that are given.

Mr. VOLKMER. All right. OK. I have no further questions. Does anyone else have any additional questions?

Mr. BROWN. May I——

Mr. VOLKMER. The gentleman from California?

Mr. BROWN. Mr. Fink, I have just reviewed the section in the report dealing with space applications, which I guess is the closest that you come to dealing with the commercialization subject per se. And I am impressed with what you say there, although I have a sense that the task force is being a little circumspect in approaching the subject.

Basically you are dealing specifically with the Earth resource observation program as probably the key application area that is ripe for development, and you make—you make the statement that a better definition is needed in that area.

Would the conversation that we had been having with various people here with regard to clarifying an operational role for NASA fit in with that recommendation for a better definition in the space application field? Is that what you have in mind, or was there—are you trying to get at something I don't understand here?

Mr. FINK. No, I think the group feels that this one area has never been articulated very clearly by NASA. It's been played a number of different ways. We recommend a particular format for applications programs in which using agencies would be brought in very, very early in the planning of the program.

Mr. BROWN. Both public and private users?

Mr. FINK. Both public and private users, depending upon what the application is, that they would therefore influence the direction of our program very strongly right from the start, that there would be plans made for the ultimate disposition of the program, either through the public or private sector, when the preoperational phase was finished.

That was not done basically in the Landsat world, and it is probably the cause of our constant flip-flopping on the program. It is being done, by the way, I think rather effectively in NASA's current communications effort, that so-called 20/30. That is exactly what they are doing, and I think that bodes well for the success of that program.

Mr. BROWN. Well, you—you sort of move interchangeably here between a discussing of remote sensing and then a—then you use the broader term space applications, but the implication is you are still talking about remote sensing but—because that is the current major area of interest.

Mr. FINK. Yes.

Mr. **Brown**. But it is of general applicability and, frankly, I am very supportive of what you recommend here as long as I am sure that I understand correctly what you are getting at.

Mr. **Fink**. We really do mean it broadly in applications. Remote sensing is used as an example.

Mr. **Brown**. All right. I think we can—the committee can be usefully guided by your statement. Thank you very much.

Mr. **Volkmer**. Thank you very much, Mr. Fink. You have been very helpful.

[Answers to questions from Mr. Fink follow:]

ADDITIONAL QUESTIONS FOR DANIEL J. FINK

1. What motivated the Council to propose a study on the "Mission of NASA"? Was there concern that NASA is losing or has lost its vision, and needed reinvigorating?

2. Your statement indicates you believe the 1958 NASA Act remains a strong guide for our space policy, although the Act did not foresee the extent to which other agencies, nations, and the private sector are involved in space today. Are we being remiss if we do not amend the Act to reflect these changes?

3. In your opinion, does NASA appreciate the number of new players in the space arena? The private sector, for instance, tells us they are awaiting signals and commitments from NASA in order to reduce risks involved in undertaking space ventures. In your opinion, is NASA doing all it should be doing in the commercialization area?

4. (a) You recommend NASA take the lead in coordinating Federal space science research activities. As the share of space-defense related research increases, how would you propose responsibilities of NASA and DOD be delineated?

   (b) Do you agree with recent recommendation of the NRC Aeronautics and Space Engineering Board that NASA and DOD enhance cooperation on basic research? Would increased ties between NASA and DOD muddy the waters still further as to NASA's status as a civil space agency, or do the potential increased benefits to both communities outweigh that consideration?

   (c) How effective are the existing coordinating mechanisms between NASA and DOD on space programs? Is there a need to establish different coordination mechanisms, perhaps reestablishment of the old civilian-military Liaison Board?

5. Did the Council address the relative balance which should exist among NASA's various programs, or "missions"? Or, is there any current or potential imbalance seen among them? For instance, some feel NASA's current involvement in operations, and potential commercialization activity, may disrupt its R&D responsibilities.

6. Did your study look at NASA's responsibilities in promoting and training an adequate supply of manpower resources to meet future space goals?

NASA
National Aeronautics and
Space Administration

Washington, D.C.
20546

Reply to Attn of

November 23, 1983

The Honorable Harold L. Volkmer, Chairman
Subcommittee on Space Science and Applications
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

I am pleased to respond herewith to the questions listed in your letter of October 27 relative to your hearings to review the National Aeronautics and Space Act of 1958. My answers are keyed numerically to your list.

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1. The motivation for the Council's proposal was twofold. First, with the Space Shuttle going into routine operation, and with a space station projected to be the next capability developed to support and expand space flight, we perceived a need to develop--or to restate--the principal mission(s) of NASA as we envisioned they should be in the years ahead to serve as a basis for NASA's longer-range planning. Second, there was a perception among some members of the Advisory Council that NASA had become too project-oriented in the past decade or more. We believed, therefore, that a mission study such as the one we conducted would highlight the broader-based goals and objectives rather than the projects, which, after all, are the means rather than the ends themselves. While we felt the need for focus, there was no concern that NASA was losing its vision and needed reinvigorating.

2. The strength of the Space Act is its breadth of coverage and the flexibility it has offered NASA to accomplish its missions. Many changes in environment, including the ones you mention, have occurred in the 25 years that have elapsed since this landmark legislation was enacted. The organization and operations of NASA have changed accordingly. This process of change will continue and I would be concerned that amendments to the Act could reduce our flexibility to respond to this unpredictable but inevitable process.

3. It is probably true that NASA is not yet doing all that may be needed in the commercialization area, since the Agency is only now formulating its policies and plans. We have a Council task force examining the plans being developed by NASA's Commercialization Task Force; when their respective works are finished and the Council has received and approved its report, we will be able to comment further on this issue.

4. (a) Any work that the DOD performs in space science is incidental to its primary military missions. NASA can take the lead in this basic research field just as it does in basic research in aeronautics, using coordinating bodies such as the AACB, the advisory committees, and similar mechanisms to ensure proper coordination in space science research. Because the research in question is basic research, I do not think a clear delineation of respective responsibilities is necessary or even desirable, so long as the work is coordinated. In applied research and in development, of course, the delineation of responsibilities would be determined by eventual applications, civil or military.

(b) We do agree with the ASEB recommendation on enhanced cooperation of NASA and DOD in basic research. Basic research by its nature is neither military nor civil, and, with adequate coordination, should be conducted by the best qualified groups. I do not believe the status of NASA as a civil space agency would be harmed by this cooperation in basic space research any more than it has been by cooperation in basic aeronautics research.

(c) Existing coordination mechanisms between NASA and DOD, particularly the AACB for aeronautics and space programs and the USAF/NASA Space Technology Interdependency Group for space technology, provide the potential for effective coordination. I see no need for the proliferation of new coordinating bodies; if deficiencies in coordination are apparent, the existing mechanisms should be strengthened.

5. The study did not address the relative balance or priorities among all the "missions" we examined. We did look carefully at NASA's mission in STS Operations; as you know, we strongly recommended that NASA separate these operations from the rest of the NASA organization and "fence" the resources employed for that purpose so that they would not encroach on R&D (and vice versa). We don't believe that NASA's role in commercialization is likely to disrupt R&D; NASA's role is to facilitate commercialization through its R&D, not to carry out commercial-like activities.

6. The Mission of NASA study did not look at NASA's responsibilities in promoting and training an adequate supply of manpower resources to meet future space goals. To the degree that NASA adopts our mission statements and implements them with programs, they will have to address this issue.

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I hope, Mr. Chairman, that these answers are adequate for your continuing review of this important matter. If the Council can be of any additional service, please do not hesitate to call upon us.

Sincerely,

Daniel J. Fink

Mr. VOLKMER. We will now go to our next witness, Mr. John Gibbons, Director, Office of Technology Assessment.

Mr. GIBBONS. Thank you, Mr. Chairman.

Mr. VOLKMER. Welcome, Mr. Gibbons. Your statement will be made a part of the record, and you may either review it in total or summarize, however you so desire. I would appreciate your identifying the gentlemen with you.

STATEMENT OF JOHN GIBBONS, DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT, ACCOMPANIED BY JOHN ANDELIN, ASSISTANT DIRECTOR; PETER SHARFMAN, PROGRAM MANAGER; AND RAY WILLIAMSON, SPACE STUDIES LEADER

Mr. GIBBONS. Thank you, sir.

We have several activities and studies underway at OTA, and with your permission I have brought with me John Andelin, Assistant Director at OTA; Peter Sharfman, who is Program Manager, which includes space areas; and last but not least Ray Williamson, who was a NASA trainee in graduate school and has led several of our space studies at OTA.

I would like to submit my full statement for the record, Mr. Chairman, and rather than try to give you a synopsis of that statement, I would like to highlight four points this afternoon.

The first is that the relationship between NASA's traditional activities and the new challenge that are placed—challenges that have been placed before it, traditionally, in the—under the 1958 act NASA has concentrated on research, on the development of vehicles, and on the—and on exploration in space simply as an extension of human experience.

Now, in recent years, additional and competing needs have arisen. These include an effective transfer of technology to new users of the things that we have learned in space and the provision of services to users.

The climate of the participants in space has changed enormously since 1958. Government is still a primary customer, outside of telecommunications, but there are increase private sector interests and also there are several foreign countries besides the U.S.S.R. that are now actors in this business, so it is a vastly more complicated and diverse kind of process than was around in 1958.

The basic problem that comes out of this is that the gap between NASA's traditional activities and the commercialization or the industrialization of those activities—that is, the gap between the research bench and the successful application of that knowledge that is learned—is a problem. We have a real gap problem.

Landsat is an important example of the inadequacy of the present arrangements, and this is especially disturbing in the face of actions of some of our competitors; for example, the French with the spot system, an innovative arrangement between government and private sector.

The issue then boils down to one of bridging; that is, of linking the research process on the one hand to the industrialization process on the other. And such a bridging requires a commitment to build institutional links and arrangements that go well beyond the present actors; that is, NASA, the academic research community and the aerospace industry.

The second point, Mr. Chairman, has to do with the separation of military and civilian programs. NASA and DOD are not, they have not been, they probably won't be and they probably shouldn't be truly independent. Especially in the early years, of course, NASA drew heavily on the military. Nowadays, if anything, the reverse is true.

NASA, in terms of real dollars, is shrinking, and the military space programs are expanding. But when we compare the military vis-a-vis civilian activities of the U.S. programs, we have to increasingly keep in mind the activities of the private sector, which even in the non-Government area are getting to be quite significant.

Now, the changing relative magnitudes of this civilian and military program could have two consequences, both of them negative.

First of all, it could make it much more difficult for NASA to compete with the Defense Department for high quality employees and for university participants, as well as for the attention of the aerospace industry, the resources in the private sector.

The second consequence is that this changing ratio could undercut the argument that we use so frequently in the international scene; namely, the argument that we have a strong commitment to the development and peaceful use of outer space.

Well, we are not arguing today for some fixed ratio of budgets between civilian and military programs, but we do want to express a concern about the character of the civilian program, which the character includes the consideration of size.

What does it take to attract and sustain the attention of good people? What is required for it to be able to foster industrialization? How can we maintain our international leadership in the civilian programs? Answers to such questions as these require careful analysis and not ad hoc decisions.

The third point, Mr. Chairman, is—concerns NASA's budget and, as an example, the space station question. Since the peak of the Apollo program NASA's real budget has declined by about two-thirds in deflated dollars.

In addition, we have changed from a time, as I have mentioned earlier this afternoon, a time in which defense supported NASA to a time in which the reverse is more nearly the case. This means that any major new undertaking, such as a manned space station, is either going to have to be done at the expense of much if not most of NASA's current programs, or that large and sustained additional funding is going to have to be committed.

If military demands continue to stress the limits of national resources to do space work, a major new NASA effort will require not only additional funds but also some substantial startup time, simply because the resources that are available across the Nation are limited.

A commitment to a space station, it seems to us, would create an Apollo type situation but different in one very important perspective; and that is, that it would have a goal without any obvious termination to it. It would be an indefinite goal.

One key question, then, is whether the space station can be justified as in Apollo as a goal per se or in itself, and that seems possible, of course, but I think it is unlikely. The public appeal of a permanent manned space facility would have to be supported, I believe, by a substantial rationale in terms of identified national need and opportunity; that is, it could lead us to something.

There is apparently little or no defense or space science interest in a space station as presently envisaged. However, it is proferred as a kind of a gateway for—that would lead to industrialization, for further exploration and for research.

Now, if that is the case then one can argue that serious considerations should be given to requiring that such an effort be some kind of a joint or cooperative venture with industry, the potential industrializer, and perhaps with foreign governments, particularly with respect to research.

The final point, Mr. Chairman, has to do with the still lack of a broad-based and permanent civilian space policy study board.

With the demise of the National Aeronautics and Space Council 10 years ago, there is no longer any congressionally established and broadly representative professional body that is charged with providing guidance on national space policy. Decisions are therefore often made ad hoc with sufficient—insufficient regard to our Nation's long-term interests and postures in space.

In our 1982 report on civilian space policy and applications, we explored several options for this kind of policy guidance. The matter of the appropriate form in which a new, effective and nonpartisan professional group should be cast continues to be very important. Let me give you an example.

If one looks at what is happening to our efforts in civilian space over time, we have moved from research and exploration as our emphasis to a more utilitarian emphasis. On the other hand, our efforts in military space, which began as a highly utilitarian one, now seems to be rapidly expanding to include research and also exploration of a different sort. What are the implication of such an enormous shift of activity in our national—overall national space program?

Well, in conclusion, Mr. Chairman, a general but accurate characterization of the 1958 act is that it is highly permissive. NASA and NOAA may, to a good first approximation, undertake the programs that they think are desirable and they may manage mandated programs according to their own likes.

This kind of permissiveness is quite appropriate for an executive agency when there is national consensus regarding its objectives, when its leadership adequately understands the context in which its activities are to take place, and when it is encouraged by the White House to take appropriate initiatives.

However, it's clear that NASA takes initiatives primarily of interest to our scientific, engineering, aerospace and military communities. It is also clear in today's context of growing international competition and of increased private sector interest in space that a civilian space program based primarily on scientific, engineering and aerospace industry imperatives, can no longer be considered appropriate.

It can't be too heavily stressed that there is a need, as we begin this next quarter century in space, to revisit carefully the goals and the directions that the United States wants to pursue in space.

The 1958 act articulated a national consensus that existed 25 years ago. Similarly, any significant reversion—sorry, revision or replacement of that act must again organize the Nation's aspirations in space for the future.

Thank you, Mr. Chairman. We would be happy to respond to questions. And if I might, if a question comes to me that I think one of my associates might give you a more appropriate answer, I would like to refer to them.

[The prepared statement of Mr. Gibbons follows:]

Statement of Dr. John H. Gibbons
Director
Office of Technology Assessment
to the
Subcommittee on Space Science and Applications
of the Committee on Science and Technology
U.S. House of Representatives
October 18, 1983

ON REVIEWING THE 1958 NATIONAL AERONAUTICS AND SPACE ACT

INTRODUCTION

The Office of Technology Assessment (OTA) welcomes the opportunity to testify before this subcommittee to assist its review of the 1958 National Aeronautics and Space (NAS) Act.

OTA is currently engaged in two major assessments of space issues. One of these, International Cooperation and Competition in Civilian Space Activities, is being carried out at the request of the House Committee on Science and Technology and the Joint Economic Committee, and will be completed this winter; the other, Civilian Space Stations, jointly requested by the House Committee on Science and Technology and the Senate Committee on Commerce, Science, and Transportation, will be completed next spring. In June, 1982, OTA published a report entitled Civilian Space Policy and Applications, a broad assessment of U.S. space policy; this was followed in September, 1982, by the publication of the OTA technical memorandum on Space Science Research in the United States. In March, 1983, OTA published another technical memorandum, Unispace '82: A Context for International Competition and Cooperation. Two additional technical memoranda, one on land remote sensing, the other on the Soviets' use of human beings on their Salyut space stations, will be published shortly. On August 4, 1982, I testified before this subcommittee on the subject of National Space Policy; a number of the statements in that testimony remain quite relevant to the subject of today's hearing.

It is indeed timely, on the occasion of the 25th anniversary of the founding of the National Aeronautics and Space Administration (NASA), to reconsider the extent to which the NAS Act is appropriate for advancing U.S. space interests into the next quarter century. The 1958 Act reflected a national consensus about the country's role in space; the passage of a quarter century, and the accumulation of considerable experience in space, make it timely to review that consensus and to ask, broadly, what the Nation's goals for the next 25 years might be.

At the outset, it is important to recognize that our next 25 years in space will differ qualitatively from the first quarter century. In my testimony today, therefore, I will touch upon issue areas indicated by the following basic questions:

1. Given our capabilities and experiences to date, what future activities and directions look most promising?

2. What should our national objectives in space be for the next quarter century?

3. Does the Act appear fully appropriate to guide our pursuit of these objectives?

I. THE NEXT 25 YEARS: WHAT SPACE ACTIVITIES LOOK MOST PROMISING, GIVEN OUR EXPANDING DESIRES AND CAPABILITIES? WHAT SHOULD OUR GOALS BE?

Today, there are more "players" in space, both from the private sector and from other countries.

In many space areas, the non-aerospace U.S. private sector is moving to take a more active role. Because we are just at the beginning of the non-aerospace private-sector provider and user involvement, we cannot know how much or how fast it will grow. Nevertheless, there are some interesting signs:

o At least three private groups are planning to develop and market commercial launch vehicles;

o at least one private U.S. group is planning to offer satellite Earth remote sensing services independent of Landsat;

o at least one private group is raising capital to develop and build a privately-owned space module with characteristics and capabilities intermediate to those of the

Leasecraft and those of NASA's proposed space station habitability module, and others are beginning to give thought to the provision of at least some portions of the latter;

- a number of private concerns are planning to market multipurpose freeflyers;

- private satellite communications continues to expand in both character and magnitude, with direct broadcast TV already on the air and international direct audio broadcasting and mobile communications for low population density areas on the horizon; in addition, international maritime communications is burgeoning;

- private attention is now being given to the provision of position-fixing and navigation equipment and services; and

- the private sector is conducting materials processing research and developmental activities in space.

In none of these cases are long-term Government subsidies involved, beyond a few initial R&D joint endeavor agreements whereby the Government provides launch services in return for which the private entrepreneurs provide the data from their experiments to NASA on a confidential basis.

Today there are also international competitors in space. The European Space Agency (ESA) is now offering commercial expendable launch services with its Ariane vehicle. By 1990, at least five foreign groups will have advanced Earth remote sensing systems. The Japanese have stolen a march on the United States with the introduction of 30/20 GHz satellite communication circuits, and European countries are studying the provision of direct-to-the-home space-based video services. This year, the Soviets have offered their Proton booster to launch Inmarsat satellites, and have the capability of entering other potentially economically profitable fields if they choose to do so. As a result, the United States, despite its acknowledged lead in most areas of space science, space technology development, and space-related operations, is no longer able to monopolize the provision of space services and hardware.

The question of a continuing human presence in space is appearing more frequently. The Soviets seem to have achieved the ability to keep some of their people in space continuously, although they have made no formal declaration that they have actually achieved it. (The recent serious accident aborting the flight of the tenth Soyuz-T mission, and the near-accident on our most recent Shuttle launch, illustrate how hazardous and demanding spaceflight still remains.) Whatever the objective value of the Soviet effort in space may be, it certainly does not go unnoticed by the rest of the world, and it does have at least some value for the Soviet Union in terms of its perception of its national interests.

There is increasing interest, not only within NASA, but also within the U.S. commercial sector, in providing a U.S. capability to keep people-in-space. NASA already has been counseled by its senior internal advisory group that it is both feasible and desirable to take a few non-technicians aboard Shuttle flights each year. Whether or not NASA constructs and operates a so-called civilian space station, it may well be that a substantial "Western" permanent in-orbit infrastructure, with an important role for human beings, will be built. The range of options whereby ESA, Canada, and Japan may contribute to the provision of such an infrastructure is being given serious attention in the ongoing OTA study of Civilian Space Stations.

Many space scientists express concern that development of a space station by NASA could drain funds away from the space science program, as they believe happened during the development of the Space Shuttle. In addition, any such overruns even if only a small percentage of the budget for a space station, could result in the transfer of a significant percentage of space science, space applications, and space technology development funds. Neither the National Research Council's Space Applications Board nor its Aeronautical and Space Engineering Board has taken a position regarding either the desirability or the cost of any civilian space station. However, its Space Science Board believes that, if funding remains adequate, space scientists, although not ready to support a commitment to a space station with human crews, would be interested in using such a facility if it were available. The attitude of the U.S. military toward development of a space station, although relatively negative to date, will remain unclear until completion of the policy reassessment initiated by President Reagan's speech of March, 1983.

Both robotics and human beings may be expected to play key roles in the thoughtful, long-term development of space, the one being well adapted for exacting and repetitive as well as remote tasks, the other providing versatility and flexibility. To the extent that an in-orbit infrastructure is publicly funded, the onboard presence of human beings is expected to generate more political support for its procurement.

New capabilities for space science also lie ahead. The next 25 years may well see both the construction and operation of large observatory-class facilities, substantially larger than the space telescope. Such facilities probably would have to be constructed in-orbit and require periodic servicing. Life scientists are interested in appropriate in-space laboratory facilities in which long-term physical, psychological, and social experiments involving human beings and other animals can be conducted over long periods of time.

We can expect a number of space applications technologies to come to fruition in the next quarter century. Materials processing in space (MPS), currently still very much in the experimental-developmental stages, shows promise to some of returning large long-term economic benefits. Remote sensing of the Earth from space, employed in a variety of competing and complementary systems, could provide additional important assistance in resource management, land use analysis, atmospheric research, mineral exploration, and physical hazard warning and containment. Satellite communications, especially if appropriate ground segments and infrastructure are put into place in less developed countries, should continue to grow at a high rate. In addition, increased use of teleconferencing in developed countries should contribute substantially to growth of demand. Broadened mobile use of satellite communications also looks promising as do navigation and position-fixing.

Newly industrializing countries must apply a significant fraction of their assets to undertake space operations, yet India, China, and Brazil have already begun to develop their ability to use the assets of space. The Western European countries and Japan can be expected to expand their space interests and activities and to seek cooperative agreements both with the United States, among themselves, and, perhaps, with the Soviet Union. The Soviets may enter the commercial realm more directly and explicitly; in addition, they are reported to be developing two reusable space vehicles, a small space plane and a heavy-lift "shuttle," to complement their space station capabilities. Thus, more, and perhaps all, countries will increase their reliance on information and services provided by space systems.

A major impediment to much broader participation of the domestic private sector and of foreign nations in space activities is that the unit costs of space hardware and space-related services are so great. This issue is a principal focus of our current Civilian Space Stations assessment. As ways are found to contain, and, eventually, to reduce, these costs, the desire and ability "to be part of the action" in space -- in transportation, power, communications, position-fixing, navigation, spacecraft servicing, laboratory and/or industrial in-orbit facilities, and, eventually, personal travel -- should become more widespread.

In summary, the space area may gradually become simply one more place where commerce, manufacturing, and perhaps even the arts and the humanities will be carried on. The question of whether to conduct a given activity in space or on the ground will increasingly become simply one of relative cost and convenience.

II. THE NAS ACT

Given the enormous potential capabilities that could be developed and the diverse activities that could be undertaken in the years ahead, it is important to consider not only which goals to set and which choices to make, but also the future role for NASA and the relationship of this role both to a growing number of Federal Agencies, to the private sector, and to its foreign counterpart organizations. Should NASA remain primarily a space research and space exploration agency, or should its charter be explicitly broadened to include market- and service-related development activities, or the provision of "extension" services (analogous to those of the Department of Agriculture) to assist the private sector in learning how to operate sooner and more effectively in space, or even, perhaps, some kinds of operational responsibiities itself? Does NASA's organizational survival truly depend on a succession of "manned space spectaculars?" Would it lose its national constituency if its activities concentrated exclusively on space science, space applications, and space technology development? Or would some middle way be preferable, wherein the balance would be shifted somewhat away from efforts involving people in space toward science and applications? In general, does the military/civilian separation mandated by the NAS Act continue to serve the country well? In addressing these questions, the Congress might consider the following two options:

1. Establish new national objectives in space or reaffirm previous ones, and ensure that national policies for achieving them are in place.

2. Provide more explicit guidelines (including limitations) on the respective roles of the private sector and the U.S. Government in economically important activities.

In the light of the space activities which the Nation may wish to pursue over the next 25 years, it is useful to review the explicit directives which the NAS Act gives to NASA. In the space arena, NASA is expected to:

- plan, direct, and conduct space activities;
- arrange for the planning and conduct of scientific measurements and observations through the use of space vehicles; and

- o disseminate information concerning its activities.

Further, the Act defines "space activities" as:

- o research into problems of flight;
- o development, construction, testing, and operation of manned and unmanned space vehicles for research purposes; and
- o other space exploration activities.

Note, particularly, that there is no mention of "space applications" as an explicit NASA responsibility. Note, too, that NASA is not explicitly responsible for the pursuit, in any form, of activities related to matters of direct economic value -- only for enhancing our culture through scientific research and exploration.

The word "research" as used in the NAS Act could be understood to allow studies by NASA in areas vital to the successful pursuit of space-related industrial and commercial goals. In fact, however, such research has been given secondary attention at best, compared to physical and biological research, solar system exploration, and space technology development and demonstration *per se*. For instance, at a time when critical attention to the economic exploitation of Landsat was needed, NASA's responsibilities were transferred to NOAA, and matters of unit cost reduction of the technology, widespread demonstration and market prompting, private financing, service creation and service offering were not addressed.

A key point is that the NAS Act and most other space-related legislation does not directly address the potential roles of mission agencies -- Agriculture, Interior, Commerce, etc. The important matter of the formal mechanisms that are required to move space applications and any space operations responsibilities from the research Agency (NASA) to the appropriate mission Agencies and/or the private sector, or, perhaps more important, from either of them to NASA, also needs to be addressed. Because the next 25 years of space activities will certainly not be confined to, nor even be primarily, those of basic and applied research, exploration, and the technology development required to support such research, it would be timely to consider the appropriate means of more directly involving existing (or new) mission agencies to address interests other than those of research and exploration.

We must keep in mind that the NAS Act itself has effectively been modified by other legislation, including the annual authorization and appropriation bills. That is, although the NAS Act was required to establish and maintain the national space research Agency (NASA) and set the basic framework within which the Nation is to pursue its space activities, Congress is quite free to pass other legislation that directs NASA to undertake specified tasks, so long as the tasks do not contradict the NAS Act, which is broad and permissive. It follows that specific legislation requiring that NASA undertake, for example, to develop applications technologies that seem to be marketable in the near term would be just as effective in expressing the will of Congress as would changes in the NAS Act.

III. AREAS OF CONCERN

The 1958 NAS Act resulted from a national consensus that the United States' interests were served by establishing a civilian space agency charged with achieving and maintaining U.S. leadership in peaceful scientific space activities. Given today's overall Federal budget constraints, it simply may not be financially feasible or even desirable for the United States to maintain leadership in all areas of space activities. In 1958, foreign competition in space was barely foreseeable; today it is a reality. Should the United States attempt to negotiate international agreements according to which different countries would assume the lead roles for different space research and exploration activities? In other words, is it timely to establish a more coherent international collaboration in these areas? Similarly, in 1958, there was very little private-sector interest in space; today, it is increasingly important, but its rapid development is hampered by high cost and a lack of appropriate institutional arrangments. Given, for instance, the creation of the Communications Satellite Corporation, is there a role in the United States for quasi-public or publicly subsidized space corporations like the French Spotimage or Arianespace, or for space-related activities similar to those now being explored by the Government in the sophisticated computer area, as a means of promoting private-sector participation? As important as these questions are, given the foreseeable context for space activities over the next 25 years, it is difficult to address them in the absence of a relatively clear idea about the overall public and private space goals for the United States.

Such goals need to address not only civilian programs and international relations but also the questions of civilian-military relationships in the space area. For no long-lasting agreement on national space goals can be reached unless the following three issues regarding the separation of the military and the civilian space programs are addressed forthrightly.

1. There is the general question of the separation of the military and the civilian programs. The original intent of the Congress, as expressed in the NAS Act, seems clearly to be that a real separation was to be established and maintained. Does the Congress wish to maintain this separation in the future? If so, should we make it more evident than it is today who pays for which capabilities? There is strong evidence that a materi~~substanti~~al portion of NASA's current budget (~~perhaps as much as $2 billion out of~~ a

~~$7 billion total~~) is directed to activities of specific value to military (including intelligence) programs, although this fact is not spelled out in the budget submissions. Obviously, if Congress were to insist that NASA's budget spell out precisely which funds serve military purposes -- and perhaps even insist that these funds appear in the Defense budget for reimbursement to NASA -- it would assist Congress in exercising its Constitutional power of the purse. On the other hand, telling the world the extent to which the military and civilian programs are intertwined could be disadvantageous, for the traditional U.S. insistence that the two are separate has been an effective element of our foreign policy.

2. Some people believe that it has been an important element of our policy in the past that the civilian space program has not been substantially smaller than the military space program. They fear that if the military space effort continues to grow, while the civilian effort remains less than half as large in real terms than it was at the peak of the Apollo program, the civilian effort will come to be seen as substantially less important than the military program. This, it is argued, would have two negative consequences: it would make it much more difficult for NASA to compete with the Defense Department for high quality Government personnel and for the attention of the

aerospace industry, and it would undercut the argument we use internationally that while our military space programs are important, our civilian space programs are equally important. One of the arguments for a permanently manned space station/platform is that it would make it necessary, worthwhile, and politically palatable to increase civilian space spending.

3. We must remember that a new civilian space effort, such as a permanently manned space station, would have to draw upon a limited stock of trained people and industrial capacity. The recent and projected increases in military space expenditures will more than absorb all the unused capacity of the aerospace industry; merely adding to NASA's budget would, in the short run, produce little additional capability but much (further) inflation of the costs of high technology space programs. A decision to pursue a manned space station/platform should call either for a very gradual phase-in of the program, to allow time for industrial expansion, or else a stretch-out of military space programs to free up the needed industrial capacity.

Clarification of NASA's Role vis-a-vis Operational Space Systems and in Providing Space-Related Services

Except for launch vehicles, NASA has no legislatively prescribed duties for operating space systems and/or providing space-related services. On balance, NASA is primarily a research and exploration agency: in round numbers, its total budget is $7 billion; of this, $2 billion is used for Shuttle development; $1 billion for in-house staff, and the remaining $4 billion for Shuttle operations, and contract space science, space applications, and space technology development activities. Should NASA remain primarily an R&D agency? If so, should there be Federal space operations agencies responsible for creating and operating space-related systems and providing goods and services after they have emerged from the research phase within NASA? What incentives does NASA have to develop space systems that are likely to lead to such operating capabilities, either within the Government or within the private sector? OTA addressed these questions in its Civilian Space Policy and Applications report, suggesting that either NASA should get involved in the creation of space operating systems and services, or new space operating agencies should be established.

Mechanisms for Encouraging Private-Sector Participation

A related issue, which might be dealt with by clarifying responsibility for operational programs, is how best to encourage private-sector participation. Despite current rhetoric at the NASA leadership level favoring commercialization of space assets and activities, there is within NASA no deep-rooted tradition and little enthusiasm at middle and lower administration levels for bringing the private sector into broad and useful participation in national, publicly-funded, space activities. An important measure of how little real interest there has been in NASA and NOAA in actually involving the private sector in an important fashion is the relatively modest sums that, to date, have been spent to do so.

Clarification of NASA's Role in Developing Space Applications

When viewed from the perspective of concern for U.S. economic development, how far should the Government R&D process extend? The traditional answer has been all the way from basic research through initial operating capability (IOC) and testing. If so, NASA must work closely with both potential provider and user communities -- both public and private. As demonstrated in the Landsat program, NASA's past record of effective cooperation with these communities is mixed at best. It may be useful to review the Landsat story as an example of what can go wrong.

There are two key points. First, the Landsat system was designed primarily to allow experimental physical research to be conducted, primarily by university and in-house Government scientists. Second, despite the small but dedicated community of users who rely on its data to conduct long-term investigations of various basic and applied kinds and, therefore, think of the system as if it were an "operational system" (in the same sense that an astronomical telescope or a particle accelerator can be used to provide data to a large number of users thereof with variegated interests), Landsat remains essentially a system basically designed to meet the needs of scientific inquiry. Thus, the program has been characterized by technology push to allow new kinds of data to be gathered, rather than any important economically-related customer demand pull. There has been little attempt to stabilize the technology at a point where large-scale public service and private economy markets could develop and no direction of NASA-NOAA-Agriculture effort toward large-scale unit cost reduction (in contrast to further sophisticated technology development). As a result, the effective market remains small in economic terms, given the cost of providing the data using the

Government's technological and operational approach. Further, the likelihood that either a convincing public service or private-sector market, or both, will evolve that could be served satisfactorily at an acceptable financial cost by the proposed NASA follow-on to the Landsat D series program, the so-called System Z program, seems vanishingly small.

In contrast, the French SPOT program has been designed from the outset as a commercial venture, aimed at developing and exploiting an appropriate market. Although SPOT is heavily government- subsidized and is not expected to turn a financial profit, it should be far more adapted to commercial users than is Landsat. In consequence, despite the technical virtuosity of the U.S. system, the French system may well become the international standard, with a substantial value to France both in building prestige and in creating a good posture for future commercial efforts.

Clarification of Important, Publicly-Funded Space Technology Development Goals

Why should some space technology development goals and space activities be pursued in preference to others? How do the choices fit into the larger picture of the Nation's overall goals?

These questions are too important to be left entirely to our present-day space communities -- civil space officials, the aerospace industry, space scientists and engineers, and space enthusiasts in general -- rather than from an informed, general public debate. That is, both civilian and military space activities are now becoming, in economic and political terms, sufficiently important to everyone to warrant a broader and more formal place on the national agenda, whatever the results of the public debate may be. Certainly the public has neither the desire nor the competence to debate the design of spacecraft or the ranking of Shuttle payloads -- or even the billion dollar question of how many Orbiters are needed. But such issues as whether space should be viewed as an important commercial-industrial area, as well as a research field, and the question of how much of our tax moneys should be spent in support thereof and to compete with foreign governments, cannot be adequately resolved without broad public participation.

Permanent Human Presence in Space as a National Goal

The Soviets are well on the way to establishing a permanent human presence in low Earth orbit, with announced intentions of establishing a lunar base and of making trips to Mars. The Europeans and the Japanese also have long-term ambitions of having some of their people in orbit permanently. In contrast, the United States has not yet decided whether a permanent U.S. human presence in space should or should not be a national goal. Acceptance of this goal would resemble the Apollo commitment in fundamental character, if not necessarily in scope and pace, but it would differ from that earlier commitment in that it would commit the Nation to a goal with no obvious termination.

The experience of the Apollo program illustrates the great economic and political benefits such a national commitment can generate; the experience of the Space Shuttle program should warn us of the risks in undertaking such a commitment. Once the program was under way, we would probably have to continue to fund it, even if to do so meant that, at times, reductions would take place in the space science, space applications, and space technology development programs -- the very programs that would, presumably, make the presence of human beings in orbit worthwhile. A commitment to a human presence in orbit should, therefore, be seen as a long-term commitment to a substantial level of funding, and evaluated accordingly.

The public is probably not aware of the extent to which NASA's budget has declined since the peak of the Apollo Program.

The number of dollars is about the same -- roughly $7 billion. However, the effects of inflation (which has been more severe in the high technology space sector than in the economy as a whole) mean that the actual buying power is roughly one-third of what it was in the late 1960s. This is accentuated by the fact that some of NASA's $7 billion is really for military rather than civilian programs. One of the subjects we are addressing in our ongoing study of Civilian Space Stations is how NASA's budget might accomodate to the cost of a space station program.

Absence of Broad-Based, Permanent Space Policy Study Body or Bodies

With the demise of the National Aeronautics and Space Council in 1973, there is no longer any Congressionally-established, broadly representative professional body charged with providing thoughtful guidance on national space policy on a continuing basis. As a result, decisions regarding space policy initiatives are frequently made ad hoc, with little regard to the Nation's long-term interests and posture in space. In its 1982 report, Civilian Space Policy and Applications, OTA explored various options for dealing with this absence of policy guidance, including reestablishing the National Space Council, establishing a Presidential commission on space, and "muddling through" with the status quo. In testimony before this Committee in August, 1982, OTA expressed reservations with regard to the focus and membership of the Senior Interagency Group (SIG), then recently established to provide space policy guidance. These reservations remain. The matter of the appropriate form in which a new, effective, and non-partisan professional group should be cast is being given focussed attention by the Advisory Panel of our ongoing Civilian Space Stations assessment.

CONCLUSION

Currently, there is widespread discussion of a possible NASA-funded civilian space station. Although the OTA study of civilian space stations is still in progress, and we not in a position to issue findings, one thing is clear: a decision for or against a large, publicly-funded space station should be made on the basis of relative desirability, i.e., as compared to competing, alternative public investment possibilities. If a space station development and procurement program were approved now -- in the context of increased spending for the military space program and decreasing purchasing power of both DOD and NASA in the high technology area -- careful consideration must be given to the effect that such a large project would have on other important parts of NASA's and NOAA's programs. Such consideration is made even more crucial by two other elements of the current situation: the emergence of foreign competition in space science and space applications and the increasing interest of a broadening portion of the private sector in entering space-related business.

To meet these concerns, there is need for a general agreement on how the Nation is to meet the space challenges of the next quarter century. There are three general approaches: first, to choose our goals and set out to accomplish them, regardless of cost -- the Apollo approach; second, to choose an annual budget rate and to do what we can within its constraints -- the space science and applications approach; third, to compromise between the first two -- the Shuttle approach. The choice of approach depends, of course, on a consensus regarding how important we judge space to be to our national interests. And this judgment, in turn, must be formed as much by reasonable forecasts of future possibilities -- economic and political, as well as technological -- as by retrospectives on past accomplishments.

In any case, the question of the appropriate size of the civilian space program must be distinguished from the nominal size of NASA's budget, given that part of the latter is spent on essentially military activities. This Committee should be conscious of the risk that, if NASA is charged with developing a civilian space station, if it continues to provide military space transportation to DOD at a price substantially below real cost, and if its budget is held relatively constant, the Nation could, in effect, be leaving much of the field of space applications to others.

As applied to space operations, are there fundamental flaws in the traditional American response to the development of new commercial-industrial service capabilities, i.e., that the private sector will increasingly assume effective responsibility for them? If there are such flaws, should the Government, perhaps, "go operational?" If so, should there be one or more separate U.S. civil space operations entities to assume responsibility for the creation and operation of space-related systems, and the goods and services that they would provide? These are the alternatives which OTA suggested in its Civilian Space Policy and Applications report.

In a world in which foreign interests are threatening to supplant U.S. leadership through the mechanism of Government-supported commercial and industrial activities and enterprises in high-technology, how can the U.S. private sector retain an appropriate percentage of world markets in space-related activities? What effective Government arrangements can be devised to make these activities more accessible to the U.S. private sector? What is the appropriate structure for U.S. public/private relationships in space-related activities? Is it a national goal to achieve leadership in space-related economic markets? In particular, and as an important contemporary test, what private-sector participation should be viewed as a prerequisite for any Federal commitment to a U.S. civilian space station program?

A general but accurate characterization of the 1958 NAS Act is that it is highly permissive: NASA and NOAA may, to a good first approximation, undertake the programs that they think are desirable and may manage mandated programs according to their own lights. This permissiveness is quite appropriate for an Executive agency when there is a national consensus regarding its objectives, when its leadership adequately understands the context in which its activities are to take place, and when it is encouraged by the White House to take appropriate initiatives. However, it is clear that NASA takes initiatives primarily of interest to our scientific, engineering, aerospace, and military communities, and it is also clear, in today's context of growing international competition and of increased private-sector interest in space, that a civilian space program based primarily on scientific and engineering imperatives can no longer be considered appropriate.

Finally, it cannot be too heavily stressed that there is a need, as we begin the next 25 years in space, to revisit, carefully, the goals and directions that the United States wishes to pursue in space. As the 1958 Act articulated the national consensus of 25 years ago, so any significant revision or replacement of it must organize the Nation's aspirations in space for the future.

Mr. **Volkmer**. That would be quite all right.

We will proceed with questioning now under the 5-minute rule. The gentleman from Texas have any questions?

Mr. **Andrews**. No.

Mr. **Volkmer**. The gentleman from Pennsylvania?

Mr. **Walker**. Thank you, Mr. Chairman.

One of the proposals that I have made in the past and mention again here today was to include some language in the 1958 act which would say that NASA should, to the maximum extent feasible, spin off those things which have been proven in research and development into a commercial or industrial activity.

Do you see any great problem with putting that kind of language into the Organic Act as one way of defining a little different role for the future for our national efforts in space?

Mr. **Gibbons**. I should think that such language could help reinforce a orientation that Congress wishes the agency to take. I don't believe that their present act constrains them from taking that kind of activity, but it depends on their own administration direction. So no, I think such an expression of interest could be quite appropriate.

Mr. **Walker**. Yeah, it is clear that the kinds of things that I think will be done in the future are perfectly permissible under the 1958 act, which is probably a tribute to the people who drafted that act.

We have very few laws in government that have survived for such a period of time and still can be said to be flexible enough to include future activities. Such a statement would seem to me to be only an effort to say that we recognize that there is a changing aspect to our space activities and that this is to be encouraged for the future, given the absence of any kind of commercialization language in the 1958 act, which again is understandable. I mean, this would seem to me to put only that kind of language in place, that we recognize that that is the change that is taking place.

Mr. **Gibbons**. In fact, I might make one small additional response, that just as in the case of research in some of the national laboratories, the notion of commercialization or industrialization of new ideas begins not at the end of a phase of research and development but even in the very beginning, when you begin to formulate the priorities for research and development.

So, such a notion of commercialization or industrialization should begin to appear even when one is structuring priorities for doing research and for carrying out development, not just at the end of that process.

Mr. **Walker**. And did I understand you to say that insofar as we seek as a national policy to justify a space station concept, that the station should probably justify—be justified on a couple of grounds: number one, that it would provide the center around with commercial and industrial activities could develop in essentially low earth orbit, and also it could provide the platform from which future scientific work could be done in the solar system and beyond?

Mr. **Gibbons**. I would expect just exactly that; namely, that one would begin to articulate the design, the functions of a space station in terms of its mission goals, uses, specific uses and objectives rather than to start with something that says well, we are going to have it this big and six to 12 people and then we will figure out what to do with it. It seems to me it ought to be from bottom up, not top down.

Mr. **Walker**. Well, but I think there is an important distinction in all of this. I think what I hear you saying, and I want to make certain that I am hearing correctly, is that it may be difficult to justify the space station investment in terms of what we have there initially, that the real justification of the space station will be in what the future developments that it will bring in both industrialization and in scientific work.

I mean, is that an adequate explanation?

Mr. **Gibbons**. Exactly. It seems to me that the space station, if one moves ahead with it, has to be justified on the basis of a careful appraisal of what we have learned with our earlier steps in space, that lead us to believe that for a variety of national reasons—industrialization, exploration, research, what have you—lead us to say that is a worthy public investment to compete with other alternative uses of public funds, public investments. And if it isn't done in that way, it seems to me it is going to be a rather frail proposal.

Mr. **Walker**. Your prepared testimony seems to indicate that many of the major nations—developed nations in the world have already made a commitment. You mentioned Japan, Europe, Russia have already made a commitment to long-term human presence in space and that we are one of the few nations that has not made that kind of commitment at this point among developed nations.

Is that what I understood from your testimony?

Mr. **Gibbons**. I think you may have read more into my statement than I meant to have there. We do have indications, a number of indications from the Soviets, by their very acts, that they are trying to put men into orbit and to—men and women into orbit and to leave them there over an extended period of time with refresher crews and all the rest.

Now, they have also pronounced that that is a long-term goal for the Soviet Union. They have also pronounced sending manned visits to Mars a part of their long-term goals, too, so one has to read between lines of rhetoric vis-a-vis serious programing.

In terms of others, the French and the Japanese, I think that is a lot more speculative because they simply haven't sent anybody into orbit yet, so it is easier for them to talk about it than it is for us now because we are getting closer to having to make rather costly decisions.

Might I ask Ray Williamson, that I see peripherally out of my eyes, wants to say something?

Mr. **Williamson**. I just might add that when the French sent somebody into space, they did it with—in cooperation with the Soviets, so they are interested in it, but they are doing it in cooperation with the Soviets rather than on their own.

Mr. **Walker**. Thank you, Mr. Chairman.

Mr. **Volkmer**. The gentleman from California have any questions?

Mr. **Brown**. Let me ask a brief question.

Dr. Gibbons, you made reference in your prepared remarks on page 27 to the demise of the National Aeronautics and Space Council and there no longer being a broadly representative, professional body charged with providing thoughtful guidance on national space policy. Since I made a similar reference in my own statement, I was struck by that.

I had forgotten that you testified on this last year with regard to the senior interagency group and you state that you had expressed reservations at that time which still remain. I wonder if you could refresh my mind as to the kinds of reservations you expressed at that time.

Mr. GIBBONS. Well, one reservation, Mr. Brown, is that, for example, the senior interagency group still—at that time and still did not have representation, for example, from the Department of Interior, from the Department of Agriculture, from the National Science Foundation, from AID or other parties at interest.

And when you don't have sufficiently broad representation, then you begin to worry about the wisdom of the counsel that such a group could give.

Mr. BROWN. Well, I have a similar concern. Of course, I suspect that the White House would argue that there are other fora, I guess, forums that—within which those agencies could express their views, but it has seemed to me an obvious lack that we did not have a representative body that was able to advise the Congress on space policy.

You haven't, I presume, come to any conclusion as to what would be an appropriate way to restructure that advisory apparatus? You mention that that is a factor in your report on your civilian space station assessment.

Mr. GIBBONS. Yes, sir, we are continuing to give that some thought because we think it is quite important.

I might ask Ray Williamson to give you our status on that.

Mr. WILLIAMSON. Well, I just would like to say that in our civilian space policy and applications report we did lay out several options for the Congress which included reestablishing the advisory council, setting up a Presidential commission with representation by the Congress, and there are a variety of possibilities that could be set up, including, Mr. Brown, your own suggestion there, I think.

Mr. BROWN. Mine is the most awkward of all of the alternatives, but go ahead.

Mr. WILLIAMSON. Well, it does seem to me that the—what we emphasized in our civilian space policy and applications report is that it be broadly based and include, in fact, representation from the private sector and not just the aerospace community. I think it is very important in this day and age to think well beyond the aerospace community in formulating national space policy.

Mr. BROWN. Well, you have an opportunity, in connection with this civilian space station assessment, to really probe that in a special set of circumstances. I am sure you are aware that we have already heard from the military that they are not enthusiastic about the space station. The National Academy isn't enthusiastic. The military for one reason, they are afraid if they had it they—if they endorsed it, they would have to pay for it. The science community is afraid it will take money away from the space sciences operation, and NASA seems to be the only one who senses the significance or importance of it

What the Congress needs in this situation is the kind of a more objective, outside, in the national interest viewpoint on this thing because, as far as I can see, we can't rely exclusively on any of the people who have already sounded off on this because of the special nature of their concern.

Mr. **Gibbons**. Mr. Brown, since this space station analysis is underway under John Andelin's division, I might ask if he would be able to add a response to your question.

Mr. **Andelin**. Mr. Brown, primarily what I guess I can say at this point is that we take seriously the concern about this advisory group and the need for consensus on our national goals. We have chosen an advisory panel for the assessment that is very broad based and does not represent in any sense the narrow interests of any given industrial or political group.

So I would hope in the fairly near future, certainly by the time we are done with the assessment next spring, we will have full information on this for you. We are looking to do so sooner, if that is appropriate, for some kind of interim product.

Mr. **Brown**. Well, that will be very helpful to the committee. What I am afraid is going to happen—and it could be good or bad—is that the President or—either the present President or a new President would have his favorite campaign adviser come to him and say it will be a big plus for you politically if you do this or you do that, and that is how the policy is made, instead of in some more objective way. Sometimes that is good and sometimes it is not very good.

Thank you.

Mr. **Volkmer**. The gentleman from Florida have any questions?

Mr. **Nelson**. No, thank you.

Mr. **Volkmer**. I have a few questions.

Dr. Gibbons, last year, in August, I believe you testified before the committee and—to the effect that the U.S. space program was technologically capable but it had to develop more flexible policies and institutions to meet changing conditions, that it was important for the Government to enlist a greater share of private resources and space technology.

The question to you is, Have we moved toward this goal since a year ago that you can see in NASA?

Mr. **Gibbons**. Well, I guess there is good news and bad news. I think that the bad news is the rather woeful tale of the attempts to do something with Landsat, and I won't go further than that at this time.

I think part of the good news is the rather successful move now toward the commercialization of expendable launch vehicles; as an example, to spin out and develop technology from NASA into the private sector. But in terms of policies, institutional arrangements, and the like, I can't say I am very excited about progress over the last year.

Mr. **Volkmer**. And are we more prepared today or will we be better prepared with no basically institutional changes, say, 2 or 3 years from now than we are today or were last year or the year before?

Mr. GIBBONS. I think if one measures the progress over the last year, it is about like the farmer that described a worker. He said, "He is pretty slow. You have to drive a stake just to see if he is moving." I believe the rationale, the urgency for progress in this direction is a lot greater than the amount that we have witnessed.

Mr. VOLKMER. All right. Now, relating that to a couple of other things you said: First, it appeared to me, at least, for major involvements and new applications that we should look at the application when we do the R&D, at the time, which if I relate that to a space station, I mean, what do we need the space station for, what are the end uses before we do the R&D.

Mr. GIBBONS. Yes, sir.

Mr. VOLKMER. All right. Now, I would also relate back to this. What are the eventual commercial applications? Where are we 25 years from now? Are we, the Government, still operating space stations or has that spun off to a commercial sector? Do you think that this is an appropriate time to even involve that type of planning in the total structure?

Mr. GIBBONS. I should think in the—if we are planning a structure or an activity that is intended at some time during its lifetime to substantially involved other parties, let's say the private sector——

Mr. VOLKMER. Yes.

Mr. GIBBONS [continuing]. Then they should be invited to the table at the outset to assist in thinking about the design with reference to their potential utilization. And it is much too late to wait until it is there and then to call in the parties and say, "Now, what would you like to do with it?"

May I ask Dr. Sharfman if he would like to add to that?

Mr. VOLKMER. All right, yes.

Mr. SHARFMAN. Just that one of the things that seems to have been in short supply over the last 25 years is the kind of cooperative joint planning between NASA and users, presumably private sector users but to some degree users within the Government as well, so that something—so that a project in the very initial stages and on into the development and building of it and use of it is conceived as both a research tool and something which will evolve into a utilitarian—into a project that has eventually commercial uses.

And that's—it's the transition that is the problem. To say NASA should do the research, build it, get it going and then spin it off is to suppose that something that is designed from the beginning as a research tool is something that will be readily adaptable to being spun off to the private sector and to commercial use. And the evidence the last 25 years is that it doesn't often work that way.

Mr. VOLKMER. All right. Are we now, to keep on with the possible problems of commercialization, looking at the structure within NASA? Do you have any recommendations as to eventually how we should start structuring it so we could commercialize the shuttle program and the operations of it and everything else in the future?

We have had one recommendation by Mr. Fink earlier that there should be a reorganization or an organization structured within

NASA, still under the Administrator, with costs fenced in purely for the operation of that shuttle fleet. Do you have any comments you wish to make on that?

Mr. **Gibbons**. I appreciate Dr. Fink's recommendations, and it seems to me one important thing he pointed out, although I am sorry that it took so long to happen, is the formation of a task group to call in the people from industry outside the aerospace industry, who are ultimately the most—probably the most important potential users of space assets. So, I think that is a very encouraging sign.

If I might ask Ray Williamson to answer.

Mr. **Williamson**. I think also the recognition that in some sense operations—costs for operations need to be fenced off from other operations within NASA is a very important direction to move in.

Again, in our civilian space policy and applications report, we made a very, at that time, very tentative suggestion about moving more of these things, for instance, like Landsat, into NASA as an operational agency and pointed out the very similar kind of thing, that you need to fence off those operations from the R&D operations or otherwise you could eat into the budget.

I do think it—those kinds of things need to be looked at and dealt with in a lot more detail than they have been in the past with those possibilities.

Mr. **Volkmer**. Do you see this as a break from the past where NASA was basically looked upon solely as a research and development organization to where now we would say definitely that it is operational and here is part of it?

Mr. **Williamson**. It certainly would be a break with the past, except for the case of space transportation. And of course, NASA has always been an operational agency—in that sense—since it was founded.

Mr. **Volkmer**. With the expendable launches——

Mr. **Williamson**. With the—yes, indeed.

Mr. **Volkmer**. All right. Now, you have commented on the projected military space expenditures probability and impact possibly on space civilians, space applications. Do you see the erosion of availability if this progresses or availability of manpower for the civilian space program?

Mr. **Gibbons**. I just heard last night that I think 60 percent of the top echelon of NASA has either turned over or is turning over in a year's time and the direction that these people is taking to the private sector, primarily defense-related activities.

So, it seems to me that is at least one small vignette of the problem of when you accelerate the demand and fill, as it were, the marketplace for these kinds of resources with the defense-oriented activities, that the civilian sector space programs are automatically going to be involved and impacted by that. So, it does affect that, Mr. Chairman.

Also, it seems to me, it can compromise some of our international cooperation programs as well, but that is more secondary, I think, to your question.

Mr. **Volkmer**. Should we not then look, as part of our space policy, the methodology of providing the available manpower, the needed manpower—I mean—in the space sciences and——

Mr. **Gibbons**. Yes, sir. You know, we have had those fellowship programs in the past. I think it's—if we foresee major changes in requirements for these kind—people with this kind of training and industries with this kind of experience and capability, then by all means we should be looking at what's required.

I think one of the problems right now is the situation seems to be quite fluid here in this past 6 months or so, so it is rather difficult to put in place a program which would necessarily take several years to begin, to yield some results. So, the problem may be moving faster than one could respond to it.

Mr. **Volkmer**. As I understand—also from your testimony—that there would be a decision made that we proceed with a space station, that we are going to impact on the science programs, or the application programs, or else we are going to have to increase funding. Is that correct?

Mr. **Gibbons**. Absolutely.

Mr. **Volkmer**. And do you also see the impact on those as to the increase in the military space program funding? I mean, in other words, do we increase military? And from what I saw this morning very briefly in the Post, the amount that is projected for the future, if that increases and if some people look upon that as space, will that not also impact?

Mr. **Gibbons**. Yes, sir, it will. In fact, because if it had—if it overstresses or overdemands from the resources the Nation has to meet that program, that's what causes inflation. And so the costs of doing this kind of business in space will inevitably escalate with a rapidly escalating demand. So, that is another point of interaction.

Mr. **Volkmer**. And we will have less then for some of our science applications?

Mr. **Gibbons**. Correct.

Mr. **Volkmer**. Now, would the—would it be better if we had an explicit applications role for NASA and defined to provide clear direction to the private sector or even the way that NASA is going specifically on those applications?

Mr. **Gibbons**. If NASA continues along the direction of moving from research and exploration toward one of high utilitarian value that is expressly aimed at developing information and technology that is useful beyond NASA itself, but useful in industry, then NASA has to take on and into its ranks, into its advisory committees, some of its potential customers for that, because the process of industrialization, the movement from research to hardware, from an idea to its application, is a continuous process, so that the ultimate applier of that idea needs to be involved at the early beginnings, not just at the end of some stage. So, it does imply a new kind of presence of skills within NASA's organization itself and among its advisers that understand the process of how you do move from an idea to a marketplace.

Mr. **Volkmer**. OK.

Mr. **Gibbons**. May I ask Peter Sharfman to add to that?

Mr. **Volkmer**. Sure.

Mr. **Sharfman**. Just to point out that the pressure for doing so is a result of two things. First, that the very success that NASA has had in developing space technology and space science has made applications that once seemed to be dreams now something for the near future; and second, that other countries are moving to develop the ability to perform these applications.

And so, we are going to be driven in the next quarter century by competition from other countries in the West in commercial and applications fields, as perhaps we were driven in the first quarter century by competition from the Soviet Union on prestige in military areas.

One way or another, I presume the country will respond. What we are trying to point out is that if NASA bears the burden of responding, then first NASA will have to learn to function in a somewhat different way in the future than it has in the past, and second, it will accentuate the squeeze which already exists on NASA's funding.

Mr. **Volkmer**. OK.

Do you have something to add to that, Mr. Williamson?

Mr. **Williamson**. I might just add to that that if the Johnson & Johnson/McDonnell Douglas experiments prove fruitful, then the products—the pharmaceutical products from those experiments—will be part of the pharmaceutical industry, not part of space.

And as that industry grows, then space and the facilities for space become a small part of a very large, already large industry; namely, the pharmaceutical industry. The same could be said for other potential uses of materials processing in space.

Mr. **Volkmer**. OK. Thank you very much, Dr. Gibbons and the others. I appreciate your being here today.

That will conclude our hearing for today. We will recess until 2 o'clock tomorrow afternoon.

Thank you very much.

[Whereupon, at 3:40 p.m., the subcommittee adjourned, to reconvene at 2 p.m., Wednesday, October 19, 1983.]

[Questions and answers from Dr. Gibbons follow:]

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JOHN H. GIBBONS
DIRECTOR

November 23, 1983

The Honorable Harold L. Volkmer
Chairman
Subcommittee on Space Science and Applications
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

Enclosed are answers to additional questions for the record that you requested in the October 18, 1983, hearing on the National Aeronautics and Space Act of 1958. I hope that these answers will be helpful in your Subcommittee's deliberations on this important subject.

If I, or any of the OTA staff, can be of further assistance concerning the issues of revising the Space Act or setting national space goals, please feel free to call. Nancy Naismith, the Program Manager for this work, can be reached at 6-2214, and Tom Rogers, the Project Director of the Civilian Space Stations assessment, at 6-2175.

Sincerely,

John H. Gibbons

John H. Gibbons

ANSWERS TO ADDITIONAL QUESTIONS FOR DR. JOHN H. GIBBONS

Question 1:

The NASA Advisory Council's report on the "Mission of NASA" study recommends that Shuttle operations should remain within NASA. Would you agree with this assessment?

Answer:

OTA has not specifically studied the question of transferring Shuttle fleet operations out of NASA. It is clear, however, that insofar as Shuttle fleet operations are required to meet further explicit NASA mission needs, there is reason for it to be clearly responsive to NASA's interests.

OTA does have some reservations about the NASA Advisory Council's Report on the "Mission of NASA." First, the United States has a large number of private-sector organizations and managers experienced in operating railroads and fleets of buses, trucks, aircraft, and ships. None of the members of the NASA Task Force on the Mission of NASA appears to be drawn from any of these relevant areas. (See the membership list in the Report, p. A-4.)

Second, the Task Force apparently organized itself into a number of sub-groups, including one designated "STS Operations Subgroup." In their fact-finding, Subgroup members met with several people from several organizations. (See the Report, pp. A-11 and A-12.) None of the persons or organizations interviewed appear to be associated with bus, truck, aircraft, ship, or railroad operations.

Third, whatever the difficulties of seeing Shuttle operations move out of the government in the near term, these difficulties might be expected to decrease with time. In the Task Force recommendations, no reference is made to any possibility of any such move beyond the observation that "the [future] NASA Deputy Administrator for Shuttle Operations [should] be charged with proposing the evolutionary steps for future management of Shuttle operations." (See the Report, p. 35.)

Thus, as this matter is considered by the Congress, questions might be raised as to the analysis performed to generate the judgment given to NASA, the appropriateness of the associated fact-finding, and whether, even in the future, broad government and private-sector interests will be sought out, and will influence, any futher judgments regarding this matter.

In retrospect, it would appear that one of the questions put to the Task Force could well have been: "Specifically, what are the present and future inhibitions to the private sector's taking over Shuttle operations and what specific steps could the government take to reduce such inhibitions and prompt any such move?"

Question 2:

a. In your view, should the National Aeronautics and Space Council be activated to coordinate and advise on Federal space policy? To what extent has the Senior Interagency Group (SIG) accomplished these objectives? Have they done so effectively, or do military/intelligence considerations dominate?

b. Congressman Brown has suggested the need for an independent advisory board to advise Congress and NASA on space policy. Do you see the need for an independent source of advice on space issues?

Answer

a. OTA does not have a finding as to whether the National Aeronautics and Space Council should be activated to coordinate and advise on Federal Space policy. The Senior Interagency Group (SIG) has been useful to the extent that it has brought space policy issues to widespread attention. However, as OTA testified before this Committee on August 4, 1983, the SIG's membership is too restricted properly to address the broad set of civilian concerns in space. Further, OTA suggested that military and intelligence considerations quite possibly do unduly influence civilian space policy issues, and that other Federal civil agencies with space interests should be made full participants.

b. OTA agrees that some extra-governmental, independent, advisory body should be established to advise Congress, NASA, and other interested groups on space policy. For example, the debate occasioned by proposals to transfer meteorological and land remote sensing satellites from the Federal government to the private sector could have benefited from policy inputs from such a body.

In its report on Civilian Space Policy and Applications (pp. 33-34 and 267-269), OTA discussed the desirability of establishing an extra-governmental, independent, advisory body. Possible forms such a body could take are currently under more comprehensive study in the Civilian Space Stations assessment.

Question 3:

Our space superiority in some senses has come to depend on our military capabilities in space. An Air Force official told Congress last spring, "Space is a place; it is not a mission. We are going to continue to do the things in space that we do in the atmosphere and on the ground and on the seas, i.e., prepare to fight and win wars."

What does this mean for our civilian space program?

Does the buildup of space weapons systems suggest the need for a closer relationship between NASA and DOD, or would this threaten NASA's status as a civil space agency?

Answer:

As the U.S. experience at UNISPACE '82 and at other multilateral meetings illustrates, U.S. diplomacy with respect to space hinges on maintaining two separate and distinct space programs: military and civilian. Although there are and will continue to be many areas of overlap between the two programs, the civilian, publicly-funded program must neither be, nor be perceived to be, a cover for military efforts.

In some respects, a buildup of military space-related research and development could contribute to keeping the supportive "infrastructure" for the civilian space program in place, whatever the relative budget priorities between the civilian and military programs during a given fiscal year. However, if the military space program were to expand too rapidly, and/or if the civilian program does not contain important technological and other challenges, there is a danger that it could drain personnel and resources from the civilian program.

In OTA's view, what may be needed is not a closer day-to-day relationship between civilian and military space managers, but better coordination at the Presidential and Congressional Committee level between the civilian and military space programs, especially in the face of increasing military space appropriations.

Question 4:

[a.] Do you see anything in the Space Act that is working against the commercialization of space and the funding of innovative space endeavors? [b.] If so, how could the language be changed to encourage such activities?

Answer

[a.] By all accounts, the Space Act is permissive of almost any sort of activities that NASA might choose to undertake. However, the particular directives which it specifies, without exception, have to do with the promotion of the physical and life sciences, the development of advanced technology and launch capabilities, and the exploration of space. Thus, the Act works against commercialization only to the extent that NASA (or any other Agency, or any Department, in the Executive Branch) is not specifically charged with seeing that it takes place.

[b] The Act could be revised to meet this objection by including language charging NASA (or some other Executive Branch office(s)) to provide mechanisms for moving the Federal government beyond basic research, and the technology development required for its conduct, into the prompting of the private sector to provide economically attractive goods, services, and processes in a sensible, expeditious manner. It might be well, however, to postpone specific revisions until the findings of the NASA Administrator's "Space Commercialization Task Force," under the direction of L.J. "Bud" Evans, are reported.

Question 5:

Is NASA's ability to assume new partnerships with industry inhibited by its own attitude? On Page 22, you have commented on the lack of enthusiasm to bring about the participation of the private sector in space. [a.] Is this a real barrier to space commercialization? [b.] If so, how can we change this?

Answer:

[a] The most senior NASA leadership appears to be seriously interested in promoting "new partnerships with industry [and commerce and the financial sector]." Such a move toward commercialization would be taken by some to imply an eventual reduction in NASA's responsibilities and, consequently, its budget requirements. But, at the same time, the NASA Adminstrator is suggesting that

civilian Government space activities be provided with 1% of the sum appropriated for all Federal activities. Such a sum would imply an increase of $1.5 billion/year on a base of $7.0 billion/year, i.e., 20%. There might be some internal inconsistency in these two views.

Based on NASA's past performance *re* commercialization activities in the applications area, and on OTA interviews with key NASA personnel, it is OTA's view that, in any event, apart from the Adminstrator's office and the Shuttle "marketing" personnel, there seems to be little evidence of enthusiasm for "space commercialization" on the part of NASA's scientists, engineers, and managers. To the contrary: such a step is (understandably) considered by some as a threat -- and to others as of no practical interest.

Clearly, this situation continues to be a real barrier to space commercialization -- if it is assumed that NASA is the organization in the Executive Branch responsible for this matter. To change these attitudes is to effect a change in a "culture" which has been inculcated through years of education and practice, and validated by NASA's undeniable technological and operational successes. It will not be easy to change this culture, and there is no obvious way to insure that any change on NASA's part would be for the better. Only recently is important interest developing elsewhere in the Executive Branch (in DOT and Commerce) *re* "space commercialization." Promoting competent and aggressive Government interests outside of NASA could be given consideration by the Congress.

One promising indication is increasing Federal flexibility, indicated by DOT's apparent willingness to take over the management of expendable launch vehicles: DOT is arranging to provide "one-stop" service to any business enterprise in applying for all the approvals needed for launches (i.e., FCC, FAA, NASA, ICC, etc.)

Question 6:

Are you suggesting, on Page 30, that the costs of developing a space station, if NASA continues to provide military transportation below cost, may be so great [that] we would have to sacrifice our space applications efforts?

Would this risk be as great if an explicit "applications" role for NASA is defined to provide clearer directions to the private sector?

Answer:

OTA agrees that the combined effects of building very sophisticated, and costly, space infrastructure, i.e., NASA's present view of a "space station," and of continuing to provide below-cost space transportation to the military, could put the civilian space applications effort at risk. If the total NASA budget is held constant, it is clear that the funding available for supporting all civilian projects is reduced by the amount of support that NASA provides to the military space program via "price-breaks" for Shuttle use. And applications continues to be the space area most at risk because it has the weakest, least organized constituency and NASA-NOAA leadership.

Giving NASA an explicit applications role could alleviate some of the risk of losing applications to foreign competition. However, a real difficulty could occur in protecting the budget line for applications in the face of increasing pressure from large programs such as the Shuttle or a space station; in times of relatively stable, fixed budgets, a small percentage cost overrun in a single, large, technology project can have a devastating effect on smaller projects. Another difficulty, of course, is NASA's modest interest, and effectiveness, in the space applications area generally. Spelling out NASA's role in explicit terms could certainly have the effect of alerting the private sector to its opportunities. (But, see our comment re the "Task Force" in 4[b].)

Question 7:

In your statement, you emphasized the need for "broad public participation" in setting space goals and priorities. In your view, what specific actions in this regard should the Congress and NASA undertake that are not now underway?

Answer:

One possibility for increasing "broad public participation" in setting space goals and priorities would be to hold hearings at various locations around the country, and to encourage interested groups and individuals currently not belonging to any organized space communities to participate therein. Such hearings could be effective if witnesses were asked to comment upon alternative sets of civilian space goals.

In the longer run, the existence of an extra-governmental, independent, advisory body on space policy would also contribute to increasing public awareness and subsequent participation in setting space goals and priorities as its findings and recommendations were released. (See our comments on 2[b].)

REVIEW OF THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958

WEDNESDAY, OCTOBER 19, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Space Science and Applications,
Washington, D.C.

The subcommittee met, pursuant to recess, at 2:10 p.m., in room 2318, Rayburn House Office Building, Hon. Harold L. Volkmer (chairman of the subcommittee) presiding.

Present: Representatives Volkmer, Nelson, Andrews, MacKay, Lujan, and Walker.

Mr. Volkmer. The Subcommittee on Space Science and Applications will come to order. Today the subcommittee continues its review of the National Aeronautics and Space Act of 1958. On this second day of our hearings on this subject, we want to delve further into discussions of space policy issues in the space science and space applications areas. To help us we have three distinguished witnesses.

I want to welcome Tom Donahue, Chairman of the Space Science Board of the National Academy of Sciences. We appreciate your joining us here today.

Willis Shapley will be representing the Space Applications Board of the National Academy of Sciences. Your longtime association with NASA as Associate Deputy Administrator will provide to the subcommittee some very useful insights.

Finally, I want to welcome John Naugle, who served as NASA's Chief Scientist from 1959 to 1979, then again from 1980 to 1981. Today Mr. Naugle is senior director of the leasecraft program at Fairchild Industries. He brings to us today a valuable background of experience from which I am sure we will benefit.

At this time, do you have any statement?

Mr. Lujan. Thank you, Mr. Chairman.

I am just pleased to be at the hearings. Yesterday's hearings were very interesting, and I hope to learn a little more today. Thank you very much.

[The opening statement of Mr. Lujan follows:]

HONORABLE MANUEL LUJAN, JR.
HEARING ON REVIEW OF NATIONAL AERONAUTICS AND SPACE
ADMINISTRATION ACT OF 1958
OCTOBER 19, 1983

THANK YOU, MR. CHAIRMAN. YESTERDAY WE HEARD SOME VERY INTERESTING TESTIMONY ABOUT THE POSSIBILITIES OF COMMERCIAL USES OF SPACE, THE NEED FOR BOTH SUPPORT AND COORDINATION OF SPACE SCIENCE PROGRAMS, THE ROLE OF THE MILITARY, AND THE APPROPRIATE ROLE OF NASA. WE HEARD TESTIMONY THAT THE SPACE ACT DOES NOT INCLUDE SPACE APPLICATIONS AS AN EXPLICIT NASA RESPONSIBILITY, AND (IF I MAY QUOTE MR. BROWN): "A MAJOR WEAKNESS IN OUR SPACE POLICY AND PROGRAMS IS OUR INABILITY TO DEFINE AND CARRY OUT THE PROCESS OF COMMERCIALIZATION." CLEARLY THE SUPPORT OF SPACE SCIENCES AND SPACE APPLICATIONS ARE NON-PARTISAN ISSUES. IN FACT, INTEREST IN SPACE TENDS GENERALLY TO BE RATHER NON-PARTISAN. SOME PEOPLE MAY QUESTION WHETHER OR NOT THE FEDERAL GOVERNMENT SHOULD BE INVOLVED IN MANY ACTIVITIES, BUT ALMOST EVERYONE SUPPORTS THE FEDERAL INVOLVEMENT IN SPACE. ABOUT ONE-TENTH OF THE TOTAL ANNUAL SPENDING IN THE U.S. FOR RESEARCH AND DEVELOPMENT GOES TO THE NASA BUDGET. THIS IS A CLEAR INDICATION OF THE STRONG SUPPORT FOR SPACE PROGRAMS.

THE ISSUES SEEM TO ARISE IN DETERMINING THE RELATIVE PRIORITIES WITHIN THE SPACE PROGRAM. MORE THAN TEN YEARS AGO WE MADE A COMMITMENT TO THE SHUTTLE PROGRAM AND NOW WE FIND OURSELVES SPENDING ABOUT HALF THE NASA BUDGET ON THE SPACE TRANSPORTATION SYSTEM. SINCE PRIVATE FIRMS HAVE ALREADY EXPRESSED THEIR INTEREST IN EVENTUALLY TAKING OVER THE SPACE TRANSPORTATION BUSINESS, WE MAY WANT TO START THINKING OF HOW WE GET FROM HERE TO THERE. IT IS HARD FOR ME TO IMAGINE AN AREA WHERE THE FEDERAL GOVERNMENT HAS BEEN SHOWN TO PROVIDE THE CHEAPEST, MOST RELIABLE, MOST RESPONSIVE SERVICE TO A CUSTOMER, UNLESS YOU WANT TO COUNT COLLECTING TAXES. WHILE PRIVATE FIRMS CONCENTRATE ON THE TRANSPORTATION SYTEM, PERHAPS THIS WILL ALLOW THE SPACE PROGRAM TO PUT LESS EMPHASIS ON GETTING THERE AND MORE EMPHASIS ON WHAT WE DO ONCE WE ARE THERE. I BELIEVE THAT WILL BE THE TRUE PAYOFF FROM THE PAST 25 YEARS, AND WILL CONTINUE TO BE FOR THE NEXT 25 YEARS, AND ON.

I SEE SEVERAL REVOLUTIONS COMING IN SPACE. THE FIRST ONE HAS RECEIVED A GREAT DEAL OF ATTENTION IN THIS SUBCOMMITTEE -- THAT IS, DEVELOPING COMMERCIAL APPLICATIONS OF SPACE. THE SECOND ONE IS THE COMING REVOLUTION IN THE SPACE SCIENCES AREA. PEOPLE ALL OVER THE WORLD WERE THRILLED WITH THE PHOTOS OF THE PLANETS -- MARS, JUPITER, SATURN -- AND WERE THRILLED AGAIN WITH THE NEWS THAT THE EXISTENCE OF ANOTHER SOLAR SYSTEM COULD BE DETECTED. BUT THESE AND OTHER THRILLS OF THE PAST WILL PALE, I SUSPECT, WITH THE RESULTS OF THE SPACE TELESCOPE AND OTHER SPACE SCIENCE MISSIONS COMING OVER THE NEXT 25 YEARS. THESE PROJECTS DESERVE MORE ATTENTION.

TODAY WE WILL BE HEARING FROM WITNESSES THAT REPRESENT BOTH OF THESE TWO COMING REVOLUTIONS: SPACE APPLICATIONS AND SPACE COMMERCIALIZATION. I JOIN YOU, MR. CHAIRMAN, IN WELCOMING OUR WITNESSES TODAY, AND I LOOK FORWARD TO THEIR TESTIMONY.

Mr. VOLKMER. All right, then. We will proceed with Mr. Donahue as our first witness.

Will you please take the witness table? Your statement will be made a part of the record, and you may either review the statement in full or summarize, however you so desire, Mr. Donahue. We will be able to get you out of here so you can catch your plane.

STATEMENT OF THOMAS M. DONAHUE, CHAIRMAN, SPACE SCIENCE BOARD, NATIONAL ACADEMY OF SCIENCES

Mr. DONAHUE. Thank you, Mr. Chairman. I thank you indeed for inviting me to participate in the very important and timely hearings you are holding to review the National Aeronautics and Space Act of 1958.

As it begins its 26th year, NASA is now clearly a mature agency. The time of youthful innovation and exploration in the development of engineering systems to support space science and applications is past. It has now demonstrated a mastery of the techniques necessary to conduct sophisticated scientific missions in space. The need to develop supporting technology is, in general, no longer a serious limitation to our ability to mount a vigorous series of investigations in any space science discipline.

As the space shuttle with its ancillary upper stages and maneuvering systems becomes available to replace expendable launch vehicles and provide us with a means to service and repair spacecraft in orbit, we find ourselves well endowed with the means to launch and support space science missions. It is interesting that this is a situation that tends to create a certain amount of tension between space science, which now wants little more than the fiscal resources to exploit its responsibilities, and the engineering and operational elements in the space program which are looking for new challenges and new ways of doing business.

Hence, I can summarize right now at the beginning of my statement what my advice as a space scientist will be. If the Nation is interested in continuing to support space science—and I shall argue vigorously that it should be so interested—then there is no need to make important changes in the present charter and charge of NASA, nor is there a need to be in any great rush to develop new technological systems. If, for considerations other than those relating to space science needs, it seems desirable to change the way of doing things or start ambitious new enterprises, I would only urge that the changes be carried out in such a way as to minimize any danger to our ability to initiate and carry out space science missions.

To support these statements, let me briefly review the status of the important space science disciplines today. There is no such thing, of course, as a space science per se. There are only scientific investigations in a number of disciplines that are carried out in space and hence need space vehicles or space systems to support them.

Clearly, major areas of investigation in astronomy and astrophysics are moving to space in order to gain access to very important ranges in the electromagnetic spectrum inaccessible from the surface of the Earth, to avoid other limitations imposed by observing through the turbulent, hazy atmosphere, or to achieve large spatial separation between antenna elements. The recommendations of the Astronomy Survey Committee chaired by Prof. George Field attest to the high priority astronomers assign to space missions.

If all goes according to our hopes and expectations, by the end of this century we shall have a system of observatories in space from which we expect to obtain the insights necessary to understand the structure of the universe and the processes that led to its birth and development. These times are among the most exciting in the history of physics and astrophysics. The marriage of cosmology and particle physics that seems to be leading us to a beautiful, unified theory of the universe has been a breathtaking event. We look forward to the information that will be produced by these orbiting observatories to provide vital contributions to the consummation of that marriage.

In the exploration of the solar system, completion of exploratory missions now planned to Jupiter and Venus will provide the framework in which we can begin intensive, focused investigation of many elements in the solar system. The purpose of these studies remains that of obtaining an understanding of the origin and evolution of the solar system and life in the solar system. I submit that this is a worthy objective.

The principal problem faced by this discipline is that some of the missions to the planets, the comets, and the asteroids that actually can be mounted with existing technical means strain the fiscal resources now available. Hence, planetary scientists have been obliged to structure their base program of missions on a scale restrained enough so that a scientifically meaningful and exciting series of studies can be conducted in an affordable fashion.

In Earth sciences, a new way of studying the solid Earth, the oceans, the atmosphere, and the biosphere has been made available to us. Looking back at the Earth from space in a systematic way promises to teach us important lessons about the interactions of these various aspects of the Earth with each other, as well as details concerning each of the interacting regions.

Last summer, under the auspices of the U.S. National Academy of Sciences, representatives of these disciplines met together and decided to ask other scientific organizations in the world to consider the wisdom of joining together later in this century in an international geosphere-biosphere program to exploit these ways of studying the earth for the advancement of our understanding of the planet on which we live. A part of that enterprise would be the study of the interaction of the sun and its radiation with the outermost magnetized plasma regions of the Earth's environment where auroras are generated. Here we have an opportunity to study at close hand the behavior of exotic media that are characteristic of those in which cosmic objects such as pulsars reside.

Now when we look at the array of exciting space missions that have been designed to address the scientific questions I have been discussing, we see that we will have to return to a rate of launching them characteristic of the late sixties and seventies—that is, a rate of three or four per year in contrast with a rate that is somewhat less than one per year at present—if we are to get them all going before the end of this century. We also find that the present institutional arrangement within the space agency and the space transportation system that is coming on line provide, in general, a very suitable framework in which we can work effectively.

There are some problem areas I shall address in a moment, but this situation does tend to render us somewhat conservative. If institutional changes should be made, such as adding an operational charge to NASA's present R&D charter, we would urge that care be taken not to change the existing structure of the agency in such a way that its effectiveness in supporting and nurturing space science be impaired.

This brings me to the issue of the relationship between NASA and the university community which constitutes the largest reservoir of space science practitioners. As a mission-oriented agency, NASA has played a role somewhere between that of the concerned, devoted guardian represented by the National Science Foundation and the indifferent operational agency represented, let us say, by NOAA.

During the administration of Mr. Beggs and Dr. McDonald as Chief Scientists at NASA, the agency has recognized that in the interest of the health of space science it needs to do more than it has in the past to insure the health and stability of the university groups that must do a major fraction of the research it carries out. Some thought might be given to the desirability of mandating that NASA ensure the viability of the science community on which the Nation depends to carry out its space science programs.

This is not a self-serving plea for a science welfare program. I am assuming that the Nation agrees that the scientific mission I have described is one that society should support. If so, the intellectual resources to carry out that program must be husbanded.

It is sometimes suggested that the support of the science investigations carried out in space and the science groups that carry out the investigations should be the charge of the National Science Foundation, while NASA is left with the responsibility to develop and deploy the technical means to launch and support these studies. As a practitioner of space science, I consider this to be a very poor idea.

Science and engineering must interact intimately in developing the peculiar kind of missions that space science undertakes. Separating the two could be disastrous. Assigning independent agencies responsibility for funding the two kinds of activities could lead to paralysis. Hence, I urge you not to be tempted to fix a machine that is working quite well in general, by dismantling it and replacing it with a new organization.

During the past several years, responsible officials have questioned whether the United States can afford to try to be preeminent in all fields of science. The same question can be asked about space science. In this case I cannot see that any damage would be done to our scientific and technological position if we could work out arrangements with other national and international agencies to mount space science missions in common. In fact, this sort of cooperation has been going on for a long time.

Historically, the United States has been the senior partner responsible for the major commitment in most of these enterprises. The resources of Europe, the U.S.S.R., and Japan are such, and their maturity in space is sufficient to warrant more ambitious and symmetric arrangements than those we have tried in the past. In fact, both the Space Science Board and NASA are involved in negotiations now with the Europeans and the Japanese, looking to set up joint missions in planetary exploration, astronomy, and solar-terrestrial physics.

If these negotiations succeed then perhaps, working together, we can undertake important enterprises that none of us feels able to afford separately. I don't see that a change in NASA's charter is needed to encourage such cooperation. However, anything you can devise to foster it and to give assurance that agreements made will be honored, would be welcome.

Therefore, my response to the question of whether the act of 1958 needs revision to facilitate a better space science program is negative. I think the charter is broad enough to allow NASA to expand its activities in this field sufficiently to exploit the great opportunities for progress that exist.

Thank you, Mr. Chairman. I will be happy to entertain any questions that you might wish to ask me at this time.

[The prepared statement of Mr. Donahue follows:]

STATEMENT BY

Thomas M. Donahue
Chairman, Space Science Board
National Academy of Sciences

Thank you for inviting me to participate in the very important and timely hearings you are holding to review the National Aeronautics and Space Act of 1958. As it begins its 26th year, NASA is now clearly a mature agency. The time of youthful innovation and exploration in the development of engineering systems to support space science and applications is past. It has now demonstrated a mastery of the techniques necessary to conduct sophisticated scientific missions in space. The need to develop supporting technology is in general no longer a serious limitation to our ability to mount a vigorous series of investigations in any space science discipline. As the space shuttle with its ancillary upper stages and maneuvering systems becomes available to replace expendable launch vehicles and provide us with a means to service and repair spacecraft on orbit we find ourselves well endowed with the means to launch and support space science missions. It is interesting that this is a situation that tends to create a certain amount of tension between space science which now wants little more than the fiscal resources to exploit its responsibilities, and the engineering and operational elements in the space program which are looking for new challenges and new ways of doing business. Hence, I can summarize right now at the beginning of my statement what my advice as a space scientist will be. If the nation is interested in continuing to support space science—and I shall argue vigorously that it should be interested—then there is no need to make important changes in the present charter and charge of NASA, nor is there a need to be in any great rush to develop new technological systems. If, for considerations other than those relating to space science needs, it seems desirable to change the way of doing things or start ambitious new enterprises, I would only urge that the changes be carried out in such a way as to minimize any damage to our ability to initiate and carry out space science missions.

To support these statements, let me briefly review the status of the important space science disciplines today. There is no such thing, of course, as a space science, per se. There are only scientific investigations in a number of disciplines that are carried out in space and hence need space vehicles or space systems to support them. Clearly, major areas of investigation in astronomy and astrophysics are moving to space in order to gain access to very important ranges in the electromagnetic spectrum inaccessible from the surface of the earth, to avoid other limitations imposed by observing through the turbulent, hazy atmosphere, or to achieve large spatial separation between antenna elements. The recommendations of the Astronomy Survey Committee chaired by Professor George Field, attest to the high priority astronomers assign to space missions. If all goes according to our hopes and expectations by the end of this century, we shall have a system of observatories in space from which we expect to obtain the insights necessary to understand the structure of the universe and the processes that led to its birth and development. These times are among the most exciting in the history of physics and astrophysics. The marriage of cosmology and particle physics that seems to be leading us to a beautiful unified theory of the universe has been a breathtaking event. We look forward to the information that will be produced by these orbiting observatories to provide vital contributions to the consumation of that marriage.

In the exploration of the solar system, completion of exploratory missions not planned to Jupiter and Venus will provide the framework in which we can begin intensive focussed investigation of many elements in the solar system. The purpose of these studies remains to obtain an understanding of the origin and evolution of the solar system and life in the solar system. I submit that this is a worthy objective. The principal problem faced by this discipline is that some of the missions to the planets, the comets and the asteroids that actually can be mounted with existing technical means strain the fiscal resources now available. Hence planetary scientists have been obliged to structure their base program of missions on a scale restrained enough so that a scientifically meaningful and exciting series of studies can be conducted in an affordable fashion.

In Earth Sciences, a new way of studying the solid earth, the oceans, the atmosphere, and the biosphere has been made available to us. Looking back at the Earth from space in a systematic way promises to teach us important lessons about the interactions of these various aspects of Earth with each other as well as details concerning each of the interacting regions. Last summer, under the auspices of the U.S. National Academy of Sciences, representatives of these disciplines met together and decided to ask other scientific organizations in the world to consider the wisdom of joining together later in this century in an International Geosphere-

Biosphere program to exploit these new ways of studying the Earth for the advancement of our understanding of the planet on which we live.

A part of that enterprise would be the study of the interaction of the sun and its radiation with the outermost magnetized plasma regions of the Earth's environment where auroras are generated. Here we have an opportunity to study at close hand the behavior of exotic media that are characteristic of those in which cosmic objects such as pulsars reside.

Now, when we look at the array of exciting space missions that have been designed to address the scientific questions I have been discussing, we see that we will have to return to a rate of launching them characteristic of the late 60's and early 70's—3 or 4 per year—if we are to get them all going before the end of this century. We also find that the present institutional arrangement within the Space Agency and the space transportation system coming on line provide in general a very suitable framework in which we can work effectively. There are some problem areas I shall address in a moment. But this situation does tend to render us somewhat conservative. If institutional changes should be made—such as adding an operational charge to NASA's present R&D charter—we would urge that care be taken not to change the existing structure of the agency in such a way that its effectiveness in supporting and nurturing space science be impaired.

This brings me to the issue of the relationship between NASA and the university community which constitutes the largest reservoir of space science practitioners. As a mission oriented agency, NASA has played a role somewhere between that of the concerned, devoted guardian represented by NSF and the indifferent operational agency represented, say, by NOAA. During the administration of Mr. Beggs, and Dr. McDonald at NASA, the agency has recognized that, in the interest of the health of space science, it needs to do more than it has in the past to ensure the health and stability of the University groups that must do a major fraction of the research it carries out. Some thought might be given to the desirability of mandating that NASA ensure the viability of the science community on which the nation depends to carry out its space science programs. This is not a self-serving plea for a science welfare program. I am assuming that the nation agrees that the scientific mission I have described is one that society should support. If so, the intellectual resources to carry out that program must be husbanded.

It is sometimes suggested that the support of the science investigations carried out in space and the science groups that carry out the investigations should be the charge of the National Science Foundation, while NASA is left with responsibility to develop and deploy the technical means to launch and support these studies. As a practitioner of space science, I consider this to be a very poor idea. Science and engineering must interact intimately in developing the peculiar kind of missions that space science undertakes. Separating the two would be disastrous.

Assigning independent agencies responsibility for funding the two kinds of activities would lead to paralysis. Hence, I urge you not to be tempted to fix a machine that is working quite well in general by dismantling it and replacing it with a new organization.

During the past several years responsible officials have questioned whether the United States can afford to try to be preeminent in all fields of science. The same question can be asked about Space Science. In this case, I cannot see that any damage would be done to our scientific and technological position if we could work out arrangements with other national and international agencies to mount space science missions in common. In fact, this sort of cooperation has been going on for a long time. Historically, the United States has been the senior partner responsible for the major commitment in most of these enterprises. The resources of Europe, the USSR, and Japan are such, and their maturity in space are sufficient to warrant more ambitious and symmetric arrangements than those we have tried in the past. In fact, both the Space Science Board and NASA are involved in negotiations now with the Europeans and Japanese looking to set up joint missions in planetary exploration, astronomy and solar-terrestrial physics. If these negotiations succeed then, perhaps, working together we can undertake important enterprises that none of us feels able to afford separately. I don't see that a change in NASA's charter is needed to encourage such cooperation. However, anything you can devise to foster it and to give assurance that agreements made will be honored, would be welcome.

So my response to the question of whether the act of 1958 needs revision to facilitate a better space science program is negative. I think the charter is broad enough to allow NASA to expand its activities in this field sufficiently to exploit the great opportunities for progress that exist.

Mr. **Volkmer**. Thank you very much, Mr. Donahue.

At this time I will recognize the gentleman from New Mexico for 5 minutes. At the end of that we will recess for the vote that we have on now, and recess until 2:45.

Mr. **Lujan**. Thank you very much, Mr. Chairman.

Mr. Donahue, I seem to get kind of mixed signals from your testimony on the space science versus space applications questions. On the one hand, I gather from your testimony you feel that space applications using the moneys there tend to diminish the opportunities for space science research, yet further on down the line you say you should not separate the two, they should both remain under NASA. Have I misinterpreted what——

Mr. **Donahue**. Oh, yes. I hope I haven't said anything of that sort, because I certainly don't want to create the impression that there is an unhealthy competition between space science and applications for support and funding. I think that I wanted to give the impression that the space science program that we would like to carry out is a very worthwhile one; that the means to carry it out, the technical means, are at hand; and the level of support, the budgetary, the fiscal level of support for space sciences is a healthy one at the present time.

Our problem, the problem in space science, is a problem with the frequency of launch opportunities that has been the consequence of the long delay in getting the space shuttle operational and the decision to phase out expendable launch vehicles several years ago in anticipation of the use of the space shuttle to launch space science missions. Therefore, while the funding necessary to carry on our programs is at a quite healthy level, unfortunately what it is now going to, it is going to keep the teams, the marching armies in place while we wait to launch our missions in the future, and not going to support new missions, development of new missions and the launching of those.

Mr. **Lujan**. Maybe I drew the wrong conclusions, because I see half the money going into the space transportation system, and maybe with that in mind I drew the wrong conclusion—that you were talking about that they were competing for the dollars, but they certainly are.

Mr. **Donahue**. No; well, you can make a case. In fact, it is a simple arithmetic exercise to look at the record. You will find that the fraction of the NASA budget going into space science has remained almost always constant, a constant fraction of the NASA budget. There was one manned space program, the Apollo program, during which space science flourished as it has never flourished since. If we can go back to that mode of operation, we need not ask for a larger fraction of the total NASA budget to support space science to carry on a very healthy program. It is a technical problem that has to do with the delay in the shuttle, that is causing us a problem.

Mr. **Volkmer**. At this time the committee will recess until 2:45.

[Brief recess.]

Mr. **Volkmer**. The committee will resume its hearing.

Mr. Donahue, I have a few questions.

Now in your capacity as Chairman of the Space Science Board, National Research Council, you reported that a space station would not be required to meet the needs of space science, I believe, at least in the foreseeable future. Do you believe that a major focus of resources on the space station might, in fact, harm the advancement of space sciences?

Mr. **Donahue.** Not necessarily. Let me back up a little bit and review just what the Space Science Board has said with regard to the space station. The Space Science Board has addressed the issue posed by a current NASA proposal for a specific kind of space station designed to support a certain number of missions in space science and applications, a major fraction of which—something like 40 percent—are space science missions.

What we did was look at this mission set and determine that the space station did not add anything, did not improve the missions that were identified in a significant way, and hence that the space station that NASA is currently talking about is not one for which there is any strong space science requirement. Therefore, the question of whether the Nation should go forward with a space station is one that will have to be decided on grounds other than the usefulness of the space station to space science, from our point of view.

What we would say is that if the Nation decides to go ahead with the space station for some reason or other, then it need not be a threat to space science. What needs to be done can be understood from the problems we are having in the present space shuttle era: That is, we are having a problem with the space shuttle not because of the funding that is going into the space shuttle, as I had just said before the recess, but because we don't have any means to launch space science missions right now while we are waiting for the shuttle.

Therefore, if a space station is built what we would say is that the means to continue to launch space science missions should be provided while the space station is being put in place, and the space station configured in such a way that if it is involved, if it has to be involved with space science missions, that it is suitably designed. Therefore, there is not necessarily any conflict between a space station program and the space science program, as we see it.

Mr. **Volkmer.** As I understand your testimony, I think several times, basically, or twice, you said that you see no need to change the Space Act in order to proceed with space science missions in the future?

Mr. **Donahue.** That is right. This is not to say that we are completely happy with the way space science is being done right now. We have our problems, and I have already——

Mr. **Volkmer.** However, that has nothing to do with the act itself.

Mr. **Donahue.** That is right. I think that those problems can be addressed without changing the basic space science——

Mr. **Volkmer.** We don't really need to add any emphasis to the science area in the act. That won't necessarily get you more dollars or a better program in the future.

Mr. **Donahue.** We certainly don't need any fundamental changes. I think probably everyone who has something to do with space can find some few words in the act that he might want to tweak and change but if we all get together and try to change insignificant words, then we are faced with a major revision, and I would just—since the thing is working my attitude is, "Let's not fix it."

Mr. VOLKMER. Getting back to the programs that have been proposed now for the future that we see, do you see additional needs in the future for additional programs for the science itself, whether it is for solar exploration or additional exploration to Mars or Jupiter or anything, other than what we have planned for the next 5 to 6 years as starts?

Mr. DONAHUE. Well, it remains to be seen what comes out in the President's recommendation in the fiscal year 1985 budget. In the particular case of planetary exploration which you have alluded to there is, I think, an excellent proposal for a base program in solar system exploration which was the fruit of 2 years of hard work by the Solar System Exploration Committee, which was chaired during a major part of his life by John Naugle, who will be testifying here this afternoon.

I very much hope that the first missions proposed in that set are actually to be found in the budget which the President brings to you in January. If that program is followed, if we can get the space station back on track and not allow the problems of the overruns in that program to adversely impact other astronomy missions—such as the advanced X-ray astronomy facility, the space shuttle infrared telescope facility, and so forth—then we have a health program, but eternal vigilance is the price of keeping it healthy.

Mr. VOLKMER. I believe you may have mentioned "space station" and you meant "space shuttle."

Mr. DONAHUE. If I said "space station"——

Mr. VOLKMER. I mean, you meant space shuttle overruns. Correct?

Mr. DONAHUE. Space telescope overruns

Mr. VOLKMER. Telescope overruns, right.

I have no further questions.

The gentleman from Florida?

Mr. MACKAY. Dr. Donahue, you have indicated that it is your opinion that the NASA statute allows sufficient flexibility so that the program can be changed and modified as new discoveries are made and new technology comes on stream. I don't disagree with that, but within that flexibility, the question I would raise would be this: Suppose, for instance in the earth sciences, suppose it becomes apparent that there are tremendous new possibilities there. What is the assurance that we have today that the administrator in NASA, the program directors, the executives will give adequate priority to those programs? I guess I am asking whether there is sufficient advisory apparatus and whether the advisory apparatus has enough priority so that we, the Congress, in the role of a board of directors, can feel comfortable that the new voices are being heard?

Mr. DONAHUE. Well, representing one of the institutions in that advisory apparatus, I have confidence in the system to recognize the need for new ways, adventurous new ways, important new ways for scientific investigations to go forward. In particular in the case of the Earth sciences, I think it is is certainly true that using space vehicles as platforms for remote sensing, there is a new way of doing Earth science, looking at the Earth as a whole, a way that is not conventional.

This is recognized. It is recognized by the Committee on Earth Sciences of the Space Science Board. It is also recognized within the Academy. I mentioned the fact that last summer at Woods Hole there was a summer study which was attended by representatives of many Earth science disciplines and others, other disciplines, who agreed that this really was something very important.

Now I have confidence that that information, that kind of advice will get to the Administrator and get to the Associate and Deputy Administrators in NASA, and that there is enough advisory apparatus in the system now to insure that those programs will be undertaken. I hope that the Congress will call on us as representatives of the Space Science Board from time to time so that—if there are problems of the sort you alluded to—so that we can discuss them with you. It is something that we have not been reluctant to do in the past when troubles developed, such as troubles that we identified in the planetary exploration program during the last couple of years.

Mr. MacKay. Do you feel, in other words, that the mechanism that now exists—which essentially, I think, puts the Administrator of NASA between the Congress and the advisory apparatus—is adequate assurance that the Congress can get independent thinking in these what I would call policy or priority issues?

Mr. Donahue. Yes. In spite of the fact that the Space Science Board, for example, is a board of the National Research Council that is set up to provide advice primarily to the Administrator of NASA, and the funding for our activities comes from the space agency through the National Research Council, we consider it a part of our charge to share that advice with the Congress and with other elements in Government such as the Science Adviser's office.

I am comfortable. I feel no restraint in coming down here and sitting with you to share that advice with you, even though it may be advice of a sort that the Administrator of NASA may not be happy to hear. Therefore, I think we have an arrangement that is working, and I don't feel any great urgency to institutionalize some change in the system.

Mr. MacKay. All right. Thank you.

Thank you, Mr. Chairman.

Mr. Volkmer. Thank you.

In other words, you do not see the necessity of having what I would call an independent, statutory enacted board, such as we had for some time in the National Aeronautics and Space Council which has been previously abolished. You do not see the need for that? You consider yourself and the Science Board sufficiently independent, from what I understand. Is that correct?

Mr. Donahue. Yes, Indeed, I do. I would point to the action that we took last summer with regard to the scientific need for a space station as evidence that the Space Science Board is a collection of very strong-minded individuals who don't hesitate to give the kind of advice that they feel it is their duty to provide, no matter how welcome it is.

Mr. Volkmer. I will give you one other. If you haven't thought about it, you don't have to give us any opinion on it. However, some of us see the continued increase in funding—and possibly even greater in the future, if some of the programs go with the military applications in space—some of us see that as a potential threat to funding for civilian applications. Do you or have you all discussed this at all?

Mr. DONAHUE. No, we haven't, and I think that it is an issue that we may well have to face up to. Our qualifications, of course, are the qualifications of scientists and we can only address issues of the health of space science, but there are some issues here that probably impact space science. It certainly would impact space science if indeed there is a contest for R&D funding between the military space program and the civilian space program. It is certainly too early—for me, from my point of view—it is too early to say whether that will be the case or not.

Mr. VOLKMER. We also had testimony yesterday from the Office of Technology Assessment that there may be a shortage of basically manpower needs, in the event the funding would increase dramatically in the military end.

Mr. DONAHUE. That is a matter of concern. It is one that the Space Science Board has not yet addressed but we are aware of the problem and it will be on our agenda for the future.

Mr. VOLKMER. Thank you very much. I have no further questions.

Excuse me. Does the gentleman from Florida have additional questions?

Mr. MACKAY. If you have not addressed these issues yet, and yet they are current issues—they are coming on, and it is almost like it is going to happen unless somebody stops it—what assurance do we have that we are getting independent thinking on a timely basis? Do you not perceive this as your role? Is your role, in other words, to give advice on topics that you are asked for advice on by the Administrator?

If that is the case—not saying this critically at all, because I think your board is doing an excellent job—but I am asking, is there a need for an expanded advisory role on these major policy questions? If the space program is going to be militarized to the extent that the civilian program is going to have to be delayed because there is not enough industrial capacity to go forward with it, then somebody just made a major policy decision, and apparently there is no one in place today who would comment on a decision at that level.

Now do you see that as part of your job at present? If not, is there somebody else in an advisory capacity who has that responsibility?

Mr. DONAHUE. I see that as our job, that is, to assess the effect of a decision of that kind on the civilian space science program. This is an issue that the Space Science Board would address, whether it is asked to or not by the Administrator. Again, the fact that we do give advice on issues on which we are not asked to give advice is attested to by the fact that just this last summer we did comment on——

Mr. MACKAY. I don't mean to be coming across as adversary. I have a genuine concern that Congress lacks an adequate foresight capability in this area, and I am trying to ask, where is our foresight capability? If the administration has made a decision and is proceeding along with it, we cannot expect them to say, "Look, these are going to be the side effects of it." We can expect them to assume that we will find that out for ourselves. That is the way the system works.

Who is there today, as a scientific expert in an advisory capacity, who could tell us that? I guess I am trying to say, Dr. Donahue, when would be a timely point for you to come to us with that warning. It seems to me if we wait until next year it is too late.

Mr. **Donahue**. It may be. I should say that the National Academy of Sciences and the National Research Council were set up by Congress and are there to advise the Congress as well as other organs of Government. If the Congress feels a need to institutionalize this system of getting advice, then it ought seriously to consider doing that. Obviously there then is some problem of conflict of interest, if the same group of people, the same board is advising the Congress and also advising agencies of the administration.

Mr. **MacKay**. However, that conflict exists now.

Mr. **Donahue**. That exists now, and I feel confident that if—in the integrity of the scientists on the Space Science Board—if we were asked to give advice formally by the Congress we would be able to do so. The issue that you point to is certainly a burning one, and we will look at it at the first opportunity and be happy to come and share our advice with you if you ask for it.

Mr. **Volkmer**. Would the gentleman yield on that?

Mr. **MacKay**. Yes.

Mr. **Volkmer**. I would appreciate it if you would look into it. Going a step further from what the gentleman from Florida has brought out, do you see any problem with, say, you or someone from the Science Board attending a hearing like this for the Congress periodically, twice a session or something like that, to go over and review things?

Mr. **Donahue**. I would welcome the opportunity. We come at least once a year, but we have always come at least once a year to testify, and we would be happy to interact with staff and to appear at any hearings at your pleasure.

Mr. **Volkmer**. Thank you.

The gentleman from Florida, Mr. Nelson.

Mr. **Nelson**. Thank you, Mr. Chairman.

Basically, Dr. Donahue, you have said that the current institutional and transportation system framework provided by NASA in the shuttle is suitable for the space science needs in the foreseeable future. Is that a fair statement?

Mr. **Donahue**. That is correct if, that is, for foreseeable future you read the next 20 years. If the space shuttle actually becomes operational and working the way NASA wants it to work, and it is equipped with the proper high-energy upper stages, it can launch all the missions that we see needed to carry out those programs that I alluded to or I discussed for the rest of this century.

Mr. **Nelson**. OK. I want to propose a hypothesis to you, and I want to have your reaction to it: As it is expected that NASA will not propose in its fiscal year 1985 budget provisions for the building of a fifth orbiter, and that we proceed with a fleet of four orbiters and in this hypothesis—and the Lord forbid—that there is something that takes out of service one of those orbiters, the Department of Defense has first priority on any shuttles. Presently, in the present schedule the Department of Defense is somewhere between 30 to 40 percent of the missions. Therefore, with one-quarter of the fleet reduced, in this hypothesis, the Department of Defense would then consume something in excess of 50 percent of the available space aboard all shuttles. Under that hypothesis, does not the concern that you advocate—that is, space science—run into serious jeopardy?

Mr. DONAHUE. Yes; I didn't mean—in my answer to your question I was addressing the capabilities of the present space transportation system as a system, and hadn't addressed the question of whether four orbiters is sufficient or not for the needs of space science.

Mr. NELSON. Have you all addressed that question?

Mr. DONAHUE. Yes; I am uneasy with an orbiter fleet that is restrained to four orbiters instead of at least five.

Mr. NELSON. Have you, as a board, taken up that question?

Mr. DONAHUE. No; we have not.

Mr. NELSON. Do you not think it might be timely to do so?

Mr. DONAHUE. It is an issue that is—it is a reasonable issue for the board to look at because it does bear on the health of space science. Even though it is at least in part an operational issue, it is a matter that we could take up.

Mr. NELSON. Well, I would suggest to you that the administration is awfully close to making a policy decision of going with four orbiters and not a fifth. If anything is to be turned around, it is going to have to be turned around within the next month or two. I would suggest of all people that have a concerned interest and/or a vested interest, as I would certainly think that the National Academy of Sciences Space Science Board would, that it is timely to express such opinions and really express them vigorously.

Mr. DONAHUE. Yes; in fact, when I appeared here earlier this year in connection with the fiscal 1984 budget, I think you and I had an exchange on this same issue. Indeed, I did agree that I thought that a decision not to go ahead with the fifth orbiter was a dicey one.

Mr. NELSON. Was a what?

Mr. DONAHUE. A dicey one.

Mr. NELSON. What is that?

Mr. DONAHUE. A rather——

Mr. NELSON. Risky?

Mr. DONAHUE [continuing]. Risky one.

Mr. NELSON. Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you. That will conclude the questions. Thank you very much.

Mr. NELSON. Mr. Chairman, I would just add—if I might, with your indulgence—I think that, other than an opinion, if you all take formal positions, that this is certainly something that you ought to take a formal position on.

Thank you, Mr. Chairman.

Mr. VOLKMER. We have one additional question.

Mr. MACKAY. Mr. Chairman, I have one more. I think that is the whole question I am raising: How do you perceive your role? If you don't take a position on this and the issue goes by, and you tell us last year it was a mistake, then you have not given us timely advice. That is the same thing as the question of militarization. I would perceive you in the role of an early warning mechanism.

That is the end of that editorial, Mr. Chairman.

Mr. **Volkmer**. Thank you.

Thank you very much, Dr. Donahue, for being here. I am sure you will have time yet to catch that plane now.

Mr. **Donahue**. Thank you.

Mr. **Volkmer**. Thank you very much.

Our next witness will be Willis H. Shapley, Space Applications Board.

Mr. Shapley, your statement which you have so kindly provided us in advance will be made a part of the record, and you may either review your statement in full or you may summarize, however you so desire.

[Answers to questions, plus additional material from Mr. Donahue, follow:]

ADDITIONAL QUESTIONS FOR TOM DONAHUE

1. Your statement seems to suggest that under no circumstances should we "rock the boat" at NASA. Do you feel that NASA really has no room for improvement in the space science area, or is change simply perceived as disruptive and perhaps threatening? Could you comment?

2. Yesterday, we heard from the NASA Advisory Council on their "Mission of NASA" Study. A primary recommendation concerned NASA's boosting its efforts to explore the solar system, and taking a leadership role in earth sciences? What do you think NASA should be doing in these areas? Is this the new frontier?

3. You have said the current institutional and transportation system framework provided by NASA and the Shuttle are suitable for space science needs over the next 20 years. Did the Board consider the use of the space station and platforms for scientific work?

4. In a recent letter to Mr. Beggs concerning the Board's position on the Space Station you say, "To meet longer range science objectives, a space station might prove to be very useful . . . if it were suitably designed." Are current plans insufficient to accommodate what should be our long range scientific objectives in space? Is this what you are suggesting?

5. You advise that changes to NASA's charter should be cautiously made to avoid disrupting the existing structure of the agency insofar as R&D is concerned. If NASA is given explicit operational or commercialization responsibilities, how do you think they would affect NASA's R&D mission? Would they strengthen or weaken R&D, in your opinion?

6. We are seeing increasing militarization of space, as plans for a new space weapons research program are revealed. The President's science advisor has said that funding for such a program may be drawn from existing R&D programs.

   a. What does this mean for our civilian space program, and NASA?

   b. Should NASA-DOD cooperation on basic research be strengthened? Or would increased ties threaten NASA's status as a civil space agency?

7. In its effort to commercialize space applications, NASA has undertaken several initiatives such as joint endeavor agreements with industry. Do you believe these have been healthy for the space sciences?

8. At present, the "care and feeding" of some disciplines of space science -- for example astronomy -- is split between NASA and NSF. Neither agency is totally responsible for the "health" of astronomy. NASA thinks of itself as "mission-oriented". By this, they mean that they focus on individual missions to space. They do not mean for example that they have as part of their mission maintaining the health of astronomy.

   a. Do you generally agree that the situation is as I have described?

   b. You say things are working pretty well and we should not be thinking of "dismantling" the system. Is there anything we should do to the 1958 Act to improve things without dismantling?

Answers to Questions put by the Subcommittee on Space Science and Applications to T. M. Donahue

1. I certainly do not want to leave the impression that I think that all is sweetness and light between NASA and space scientists, or that under no circumstances should you rock the boat. The issue is whether you need to change NASA's charter in order to correct the problems that exist. As I see it where there are problems they are not the result of poor rules for the game, but poor execution on the part of the players. There is certainly room for improvement in the way we do space science. The most serious need is for an increase in the rate at which science missions are launched. To achieve that goal what you have to do is to get the shuttle and its upper stages flying regularly, not change the basic legislative charter.

2. The recommendations referred to speak to exploration and understanding the solar system for human benefit and earth studies in areas that concern global change of importance to the support of human life. The task force identified areas for exploration by NASA that reach beyond the usual ones of traditional space science -- those explored by such planetary missions as Voyager, Pioneer Venus and Galileo, for example. Exploration of objects like the moon and the asteroids for resources that could be used eventually by humanity is recommended. Although this activity is a little outside the charter of the Space Science Board, I would comment that it is an intriguing notion and is worth pursuing -- although not at the expense of basic science missions. In the case of the studies of global change from space -- this is an exciting idea. It seems to me that NASA has a fundamental role to play here. Such a program would form a key element in an international program such as the International Geosphere-Biosphere Program now being considered by the National Academy of Sciences. Missions like the Upper Atmosphere Research Satellite, the Ocean Topography Exploration Mission (TOPEX), and the Geodynamics Research Mission (GRM) are examples of enterprises that attack these problems. It is not excessive imagery to characterize these activities as constituting the new frontier.

3. Yes sir. I attach the Board's official position on the Space Station, and testimony I gave to the Senate Subcommittee on Science, Technology and Space in response to this question.

[See Appendix 3.]

4. No sir, to the contrary. There is a first rate program of missions addressing first order science missions in the queue. I refer you here to the statement to the Senate Subcommittee I have referred to already. The quote you referred to addresses uses to which a space station might be put after we have completed our current set of missions. That would take twenty years to accomplish if we

Answers to Questions . . . continued

get the launch rate up to a decent level of 4 or so per year. Afterwards you could think of using a space station for activities such as deploying very large antenna arrays in space or building novel space craft in orbit.

5. I would be very concerned about increasing NASA's responsibility in this way. I would strongly urge that these activities be fenced off in such a way as not to interfere with the traditional R&D mission of NASA.

6. Resources -- in skilled people, in industrial base and in funds -- are limited. It seems to me that there is a serious risk that the space weapons research will draw on all three kinds of resources at the expense of basic research. I would deplore that development. As to your second question I do not see any point in mixing DOD with NASA in support of basic research. The decision long ago to create NASA as a civilian agency and to give it responsibility for nurturing and conducting space science was a sound one. There is no reason to change it now.

7. Insofar as they promise to put more resources at our disposal they could be helpful.

8. Your characterization of the nature of the mission orientation of NASA is accurate -- certainly as to the attitude of NASA throughout most of its history. There are abundant signs that the attitude of NASA is changing. As more and more of the activity in astronomy shifts to orbiting observatories -- Einstein, IRAS, IUE, ST, AXAF -- NASA is recognizing a larger responsibility here. The establishment of the Space Telescope Science Institute is a harbinger of change. The administrator of NASA authorized the Chief Scientist of NASA, Dr. McDonald, to join me in setting up a committee to examine NASA-University relations this past year. In doing so, he acknowledged a responsibility on the part of NASA to insure stability for space research groups at our universities. The attention to programs to understand global change addressed in an earlier question shows an inclination for NASA to go beyond mere configuring and flying of space missions. I think that these are moves in the right direction. If a charter change is needed to insure that NASA takes responsibility for the general health of the science areas it services, then it should be taken. In this respect I would modify my testimony.

STATEMENT OF WILLIS H. SHAPLEY, MEMBER, SPACE APPLICATIONS BOARD, NATIONAL RESEARCH COUNCIL

Mr. SHAPLEY. Thank you, Mr. Chairman. I am happy to be here again, for the second time this year, under the same circumstances. In both cases the committee was kind enough to invite the Chairman of the Space Applications Board to appear. In both cases—unfortunately, and to his regret—Mr. Harter had to attend to his businesses on the west coast, and asked me to appear for him again today.

I will skip the biographical paragraphs in the statement and the description of what the Space Applications Board is and does, because I believe that is probably familiar to the members of the committee.

Let me go directly, then, to the questions which you asked the Space Applications Board in your letter of September 13, Mr. Chairman. The question you asked was, how do we view NASA's future mission in space applications, particularly NASA's role vis-a-vis the private sector?

NASA's future role in space applications depends in part on the way the overall national structure of civil space applications activities evolves. As the subcommittee is well aware, this structure is currently in a state of flux, ferment, and experimentation. The outcome of the current effort to promote a major new private sector involvement in Earth remote sensing activities will not be known for many months.

The novel NASA-industry cooperative approach embodied in the Advanced Communications Test Satellite program is also an experiment that is now only in the early stages of its first test. The NASA arrangement with McDonnell Douglas and Johnson & Johnson for materials processing work in the space shuttle is another experiment in working out constructive Federal-industry relations in space applications.

In this situation it is not possible, and perhaps not even desirable, to lay down hard and fast statements of the mission of NASA in space applications or the mission of the other players. Certainly in our view it is not desirable to try to freeze them in legislation at this time.

However, discussions in the Space Applications Board over several years have led us to believe that NASA's research and development role in space applications should be governed by the following general principles, which should be recognized in NASA, in the executive branch, and in Congress as decisions are made on NASA programs and budgets. Our views parallel closely those of the NASA Advisory Council in this area, which were presented to you yesterday by Dr. Fink.

I should mention that Dr. Fink was formerly Chairman of the Space Applications Board and that our chairman, George Harter, took part in the deliberations of the NASA Advisory Council on this subject, so it is not surprising that our views are so closely parallel. I believe my statement will go into some degree of further detail than Mr. Fink's did yesterday.

We believe that NASA's mission in space applications should include, first, identification of civilian space applications. NASA should be responsible for taking the leadership, with active participation by the other agencies and interests involved, in systematic reviews of existing and possible future civil applications of space.

An advisory committee structure patterned on that of the former National Advisory Committee for Aeronautics should provide a formal mechanism for the involvement of selected participants from: First, the prospective users and providers of services in the private, public, and academic sectors; second, the pertinent scientific, technical, and industrial communities; and; third, the interested civil and defense agencies of the Federal Government. The reviews would identify the user requirements to be met and the requirements and priorities for research, technology development, testing and demonstration, user experimentation, and market development. That is what I have called the identification function.

Second, conduct of research and technology development: NASA should be responsible for conduct and support of research and development of essential components and subsystems of space and ground systems for civil space applications, where such research and development is not being and cannot reasonably be expected to be conducted and paid for by the private sector or by the Department of Defense or another Government agency.

Third, tests, demonstrations, and experimental operations: NASA should also be responsible for conducting and supporting, under such cooperative arrangements with the private sector and other Government agencies as are most suitable in each instance, systems tests, demonstrations, and experimental operations in cases where, one, potential benefits and users have been identified and, two, the private sector cannot reasonably be expected to pay the full cost and, three, the application is not clearly within the mission of another Federal agency.

Fourth, operational systems: NASA should be responsible for fostering the transfer of useful civil applications systems to the private sector or to other Government agencies, except when such responsibility is specifically within the mission of another Government agency.

The foregoing somewhat bureaucratic formulations seek to convey the sense of some of the main thrusts of the thinking of the Space Applications Board. I should mention that one of the reasons they are so bureaucratic sounding is that we have tried to put together a statement that covers many diverse fields—everything from space communications to materials processing to earth remote sensing—and in the real world different arrangements have to be worked out in each of those areas, so that by the time you try to put this in the form of general principles you get some good bureaucratic language.

However, what we are trying to convey are the thrusts of the thinking of the board for several years, and these thrusts can be stated more clearly, perhaps, as follows: First, an early and effective involvement of the potential users of space applications is essential to maintain a healthy balance between technology push and demand pull. Both are essential for progress.

Second, the national interest demands a continuing and vigorous program of research, development, and testing in promising fields of space applications.

Third, there is an important and legitimate role for Federal Government participation in cooperative public-private programs for systems tests, demonstrations, and experimental operations of civil space applications systems.

Fourth, careful planning of institutional and financial arrangements must precede the transfer of civil space systems to the private sector or other operational agencies.

Mr. Chairman, I have not addressed directly the question of the need for changes in the space act. Perhaps I should comment that our view is that the present space act is adequate for the situations as we see them. The basic legislative authorization is not a limiting factor.

We note that this can be and has been fine-tuned each year by Congress action, through this committee, on the annual authorization acts. For example, some years ago the upper atmosphere research section was added to the authorization act to meet a need at that time where the mission of NASA was not clear. Therefore, I believe our view on the space act would be that the basic, Organic Act is adequate, does not need to be changed, and that fine tuning year by year could well be the way to go.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Shapley follows:]

Statement by

Willis H. Shapley
Member, Space Applications Board
National Research Council

before the
Subcommittee on Space Science and Applications
Committee on Science and Technology
U.S. House of Representatives
19 October 1983

Mr. Chairman and members of the Subcommittee, on behalf of the Space Applications Board of the National Research Council, I would like to thank you for your invitation to our Chairman, Mr. George Harter, to participate in this hearing. Since Mr. Harter was unable to be in Washington today, he and the Board asked me, at our meeting on October 5, 1983, to attend in his place to present, as you requested, the current thinking of the Board on NASA's future mission in space applications.

My name is Willis Shapley. I have been a member of the Space Applications Board since 1978. From 1965 to 1975 I was Associate Deputy Administrator of NASA. Prior to 1965 I was the senior official on space matters in the Bureau of the Budget (now OMB) where I was directly involved in the development of the National Aeronautics Space Act of 1958 and the creation of NASA.

The Space Applications Board was formed by the National Academy of Engineering in 1973, and is now a part of the National Research Council, the operating organization of the National Academies of Science and Engineering. The Board's functions are to help formulate the nation's program for practical applications of space systems, to give independent advice to NASA and other agencies, and to assist in broadening the understanding of industry, universities, government, and the public of practical applications of space technology. The Board's charter and a list of its present members are attached.

Mr. Chairman, your letter of September 13, 1983, asked that we address how we view NASA's future mission in space applications, particularly NASA's role vis-a-vis the private sector.

NASA's future role in space applications depends in part on the way the overall national structure of civil space applications activities evolves. As the Subcommittee is well aware, this structure is currently in a state of flux, ferment, and experimentation. The outcome of the current effort to promote a major new private sector involvement in earth remote sensing activities will not be known for many months. The novel NASA-industry cooperative approach embodied in the Advanced Communications Test Satellite (ACTS) program is an experiment that is now in only the early stages of its first test. The NASA arrangement with McDonnell Douglas and Johnson & Johnson for materials processing work in the space shuttle is another experiment in working out constructive federal-industry relations in space applications.

In this situation, it is not possible, and perhaps not even desirable, to lay down hard and fast statements of the mission of NASA, or the other players, and certainly it is not desirable to try to freeze them in legislation at this time. However, discussions in the Space Applications Board over several years have led us to believe that NASA's research and development role in space applications should be governed by the following general principles which should be recognized in NASA, in the Executive Branch, and in Congress as decisions are made on NASA programs and budgets. Our views parallel closely those of the NASA Advisory Council, in whose deliberations our Chairman, Mr. Harter, took part.

We believe that NASA's mission in space applications should include:

1. Identification of Civilian Space Applications: NASA should be responsible for taking the leadership, with active participation by the other agencies and interests involved, in systematic reviews of existing and possible future civil applications of space. An advisory committee structure patterned on that of the former National Advisory Committee for Aeronautics (NACA) should provide a formal mechanism for the involvement of selected participants from (1) the prospective users and providers of services in the private, public, and academic sectors, (2) the pertinent scientific, technical, and industrial communities, and (3) the interested civil and defense agencies of the federal government. The reviews would identify the user requirements to be met and the requirements and priorities for research, technology development, testing and demonstration, user experimentation, and market development.

2. Conduct of Research and Technology Development: NASA should be responsible for conduct and support of reseach and developmemt of essential components and subsystems of space and ground systems for civil space applications, where such research and development is not being, and cannot reasonably be expected to be, conducted and paid for by the private sector or by the Department of Defense or another government agency.

3. Tests, Demonstrations, and Experimental Operations: NASA should also be responsible for conducting and supporting, under such cooperative arrangements with the private sector and other government agencies as are most suitable in each instance, systems tests, demonstrations, and experimental operations in cases where (1) potential benefits and users have been identified, (2) the private sector cannot reasonably be expected to pay the full cost and (3) the application is not clearly within the mission of another federal agency.

4. Operational Systems: NASA should be responsible for fostering the transfer of useful civil applications systems to the private sector or other government agencies except when such responsibility is specifically within the mission of another government agency.

The foregoing somewhat bureaucratic formulations seek to convey the sense of some of the main thrusts of the thinking of the Space Applications Board.

1. Early and effective involvement of potential users of space applications is essential to maintain a healthy balance between "technology push" and "demand pull". Both are essential for progress.

2. The national interest demands a continuing and vigorous program of research, development, and testing in promising fields of civil space applications.

3. There is an important and legitimate role for federal government participation in cooperative public-private programs for systems tests, demonstrations, and experimental operations of civil space applications systems.

4. Careful planning of institutional and financial arrangements must precede the transfer of civil space systems to the private sector or other operational agencies.

Mr. Chairman, this concludes my statement.

Willis H. Shapley

Mr. Shapley was born in 1917 in Pasadena, California, and was educated at Harvard College (1934-36) and the University of Chicago (1936-42), where he was a graduate fellow and research assistant in political science.

He entered government service in 1942 with the Bureau of the Budget, Executive Office of the President, where for twenty-three years he specialized in research and development, national defense, and space programs, becoming, in the 1960s, Deputy Chief of the Military Division and Special Assistant to the Director for Space Program Coordination.

In 1965 Mr. Shapley became Associate Deputy Administrator at NASA, in which position he served for ten years as the principal senior assistant to the Administrator and Deputy Administrator of NASA.

Since retiring from his NASA position in September 1975, Mr. Shapley has been a consultant to the Administrator of NASA, the American Association for the Advancement of Science (AAAS), the Office of Management and Budget, the Office of Science and Technology Policy, the Office of Technology Assessment, and other organizations. For the AAAS, he has been the author or principal author of the annual AAAS reports on research and development, beginning with Research and Development in the Federal Budget: FY 1977, published by the AAAS in August 1976, and continuing through Research and Development: AAAS Report VIII, published by the AAAS in June 1983. He has been a member of the Space Applications Board since July 1978 and is a trustee of Science Service.

Mr. Shapley has received the Bureau of the Budget Exceptional Service Award (1963), the Rockefeller Public Service Award (1956), NASA's Distinguished Service Medal (1969), and the career Service Award of the National Civil Service League (1971).

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Charter for the Space Applications Board

The Space Applications Board of the National Research Council will:

Provide to all elements of the Federal Government, including Congress, expert independent advice and broad judgment on the national program for the useful application of space systems in terms of issues, appropriate activities, international relations, and related priorities, emphasizing ways to augment its positive effects on society and diminish or eliminate its negative effects.

Collect and analyze information on the developing needs of concerned segments of the user community and inform them of the state-of-the-art and potentials of space techniques and capabilities.

Stimulate active collaboration among the various components of the governmental and industrial communities whose combined interest and resources will be required to achieve maximum benefit from space applications.

Conduct timely follow-up and impact analyses to assess the effectiveness of recommendations, determine the causes for success or failure, and recommend appropriate remedial actions.

Provide guidance on organization and management problems to the extent necessary to achieve the objectives of the space applications program.

Mr. **Volkmer**. Thank you very much, Mr. Shapley.

In other words, to pursue your last statement, you do not believe that there is any need to change the Organic Act to provide for commercialization or for bringing private industry more into involvement, into programs, applications programs, or even to provide in the language that they are to pay a percent of the cost of any of these programs which they are involved in.

Mr. **Shapley**. That is correct, Mr. Chairman. There are many portions of the National Aeronautics and Space Act—which, I mentioned in my biographical material, I helped draft many years ago—there are many parts of that that could be improved on and do not reflect the situation of today as well as they might. It could be written better, and that might be a worthwhile undertaking.

However, as far as prosecuting the programs is concerned, I think there are very great advantages in not trying to lay down a general statement trying to solve all problems in general, in advance. I think the tailoring of congressional decisions year by year, providing such authority as is needed and withholding such authority as they do not wish to have available, is a much better way to deal with such a complicated and dynamic area as space, especially space applications.

Mr. **Volkmer**. All right. In some areas there are no user communities for space technologies, new technologies that are developed. How can or should the Government build up a user group in such areas, or is that possible even?

Mr. **Shapley**. Well, it is difficult, as we have found, especially in the Earth remote sensing area. I believe that both the executive branch and the Congress should insure that someone has a clear mandate to do that and is given the resources to do it. For many years NASA did have a program, as urged and supported by this committee, in technology transfer and especially in the Earth resources area. This has now been largely discontinued. This does not exist. I think a case can be made that it is up to the user communities themselves to get themselves organized, but probably the best answer is to have cooperative efforts, and it would help if there were a clear understanding all around whose mission that was.

Mr. **Volkmer**. Does the gentleman from Florida have any questions?

Mr. **MacKay**. Well, Mr. Chairman, I would like to pursue, if I might, the same question that we were asking Dr. Donahue: That is, how do you assess the current Federal space advisory apparatus? Is it sufficiently strong to assure its independence, or would there be hesitancy to make foresight or early warning type assessments that "We think this particular trend is a mistake"? For instance, should we have heard from you—or we may have and I am not aware of it—on the proposal to commercialize Landsat and Metsat, which proposals were not uniformly admired in the Congress?

Mr. **Shapley**. Well, you did hear from us on that. You did not hear from us before it first happened, and it is a little bit hard to anticipate everything that is going to happen. However, I think that the process is working in the case that we are talking about, because between the time the notion of commercialization was surfaced and the present, there has been no shortage of advice on all sides. We have been up here.

You can't very well give advice on proposals that haven't been made yet. Therefore, something has to trigger the process, and I think in this case it did. I think that Congress has devoted a great deal of time to it. We certainly have, and everybody has pitched in and given their advice. Therefore, I think in this case the system has worked about as well as you could expect.

Mr. MacKay. Do you feel that the membership on your board is sufficiently broad to assure independence? Would there be any inherent—I don't want to use the word "intimidation"—but would there be any inherent hesitancy on the part of members of your board to say things that were critical of NASA policy?

Mr. Shapley. Knowing the men and women on this board, I would say emphatically there would be no hesitancy at all.

Mr. MacKay. I am asking this question out of absolute ignorance: Are any of them associated with people who are contractors with NASA, or doing research or consulting with NASA?

Mr. Shapley. Yes. Yes, sir. Several of them are.

Mr. MacKay. As many as a majority of them?

Mr. Shapley. I would have to check. I would say probably about 50 percent, although——

Mr. MacKay. You don't think that that relationship would cause any hesitancy?

Mr. Shapley. Well, I——

Mr. MacKay. My human experience tells me that it would cause hesitancy. Maybe scientists are different from everyone else.

Mr. Shapley. Well, our board is not really made up of scientists as much as it is of people interested and knowledgeable of the various applications areas. Now there are some members of the board who hold positions in the aerospace industry, and of course the aerospace industry does business with NASA. Others, as you can see from the list of membership attached to my statement, are from local government areas, from small business companies that are interested and knowledgeable of the problems of making use of space data.

The Academy has rather careful conflict of interest procedures which, very briefly, are based on the principle that you don't exclude people who have a potential conflict of interest, but everybody's conflicts of interest are formally declared and taken account of in evaluating such advice as comes out. I think this gives us a lot of expertise that we could never possibly have if we had only people who were so pure that they weren't connected with anything.

Mr. MacKay. Oh, I don't disagree with the policy. I think it is realistic and appropriate policy. In the absence of that policy, we couldn't have state-of-the-art people doing the advising. I am just wondering if the composition of the board—if it was a statutory council or if it had additional strength in terms of a broader base of membership—if there would not be less of a question of the hesitancy of the board to give independent and perhaps critical advice.

Mr. Shapley. Well, the Space Applications Board members are appointed by the Academy and not by NASA, even though it is also true, as Dr. Donahue said in the case of the Space Science Board, that funding support for the board is provided by NASA through the Academy. However, the members are independently selected, and so I think there is a great deal of independence.

Mr. MacKay. All right.

Thank you, Mr. Chairman.

Mr. Volkmer. Thank you very much, Mr. Shapley.

One little area I would like to get into just a little bit further, and that is in the materials processing program of NASA and how it applies to the applications: We have had, you know, many authorizations and appropriations of funds for a center for excellence in this, to do further research. There are some, I'm sure, that feel that maybe we should just go to the actual applications like McDonnell Douglas and Johnson & Johnson have done on electrophoresis, and others think that we need further basic research before we can go to those further steps on other possible uses of materials processing. Do you wish to comment on that?

Mr. Shapley. Yes, sir. I would say that the view of the Space Applications Board is that the two approaches are not incompatible. A very significant study of materials processing was made by the board about 3, maybe 4 years ago now. At that time its recommendations were very strongly that more research and experimentation was urgently needed to establish the feasibility of many of the proposals that had been discussed, and I think the board still agrees that there has to be a strong, continuing research aspect in the program.

However, that by no means excludes the possibility that individual companies and entrepreneurs might come forward with short-term applications they wish to try. Experiments of this sort can be performed on the space shuttle. There have been many of those that have been proposed. The most highly publicized are those of the McDonnell Douglas/Johnson & Johnson group, but other experiments have been done. Our friends the Germans will be running experiments in materials processing on the spacelab when that gets launched.

No, I think we can move in both directions, but the board strongly urges that we not try to do only the immediate applications but continue the research.

Mr. Volkmer. This is where I see, this is one of the applications programs, the materials processing, where we have—do you agree with this statement? A lot of potential users but not very many actual users at the present time?

Mr. Shapley. I think that is correct.

Mr. Volkmer. OK. I have no further questions.

The gentleman from Pennsylvania?

Mr. Walker. Thank you, Mr. Chairman.

Would you agree with the testimony that we heard yesterday which indicated that the principal mission of NASA ought to be in the exploration area?

Mr. Shapley. Well, it depends a little bit on how you define "exploration." I think I am personally very interested and enthusiastic about exploring the universe in a literal sense, getting out there, seeing what it is, and the science thrills me very much. "Exploration" to me also includes exploring possibilities of using all the knowledge that we have, too, so if "exploration" can include what I would call research in the applications of space—the part of the program that I am testifying about here today—then I would agree with exploration.

Mr. **Walker**. Well, let me take a corollary to that: Would you support amending the Space Act to include commercialization as a part of our national policy?

Mr. **Shapley**. Well, as I testified a few moments ago, I think that we can take the correct steps, one by one, in each area, without a basic amendment in the Space Act. I feel that in each area of commercialization or other aspects of the applications program, you need to take the right step for that case rather than attempting to generalize in legislation a policy applicable in all areas.

I feel, for example, that the policies in communications, the correct policies in communications, are likely to be different from the correct policies in Earth applications, and those both will be different from the correct policies in materials processing. Therefore, I was advocating essentially leaving the basic Organic Act the way it is, but fine tuning it each year in the annual authorization process, which is what the Congress has been doing really for several years.

Mr. **Walker**. I understand what you are saying. The one thing that bothers me when I look at the Organic Act, however, is that in 1958 when it was passed we really were just on the threshold of something. It speaks to commercialization noplace. There is nothing in the Organic Act which indicates that. I would agree that it is certainly flexible enough to allow commercialization, but that is applying the concept in the negative, then. We are saying that, "Yes, it is flexible enough to get there."

Wouldn't there be some advantage in having a positive statement within the act saying that everything should be done, insofar as possible, to encourage commercialization? Shouldn't that be a part of that which we as a nation are moving toward doing, and shouldn't the act under which we mobilize our resources indicate that that is one of the parts of our policy?

Mr. **Shapley**. Well, this might be helpful. A clear policy declaration in the act would probably be helpful, yes.

Mr. **Walker**. Yes, I would agree. I don't think that we ought to go through and begin, within the Organic Space Act, to say, "This is how we are going to commercialize and set up all of the ways and means of getting to commercialization within the Organic Space Act." I think we would make a tremendous mistake doing that.

For one thing, we can't anticipate what we need in terms of commercialization and industrialization for the future, but it does seem to me that there is some advantage in having at least some acknowledgment within the Space Act that commercialization and industrialization in space are, in fact, a direction that we are going to be moving and are a direction that should be encouraged. That is what I was looking for, was to find out whether or not that seems to be in the same ballpark as what you are talking about.

Mr. **Shapley**. That would certainly be consistent with the views I have been presenting.

Mr. **Walker**. I apologize. I was at another meeting and didn't get in here. Do you see a need for the Space Advisory Board, as has been proposed by Congressman Brown?

Mr. **Shapley**. I am not familiar with the specifics of his proposal. As a general matter, and now I am speaking as an individual because this isn't something the Space Applications Board has discussed, I feel that additional statutory advisory committees will probably end up building in inflexibilities, and would not really contribute as much as people would hope.

The experience we had with the National Aeronautics and Space Council for the couple of years it was in existence, was that it performed some useful functions. It helped organize, mobilize support for the space program, and provided a source of information, but I don't think that it has been missed all that much now that it is not there. I am not aware of a function that would require that.

Mr. **Walker**. Thank you, Mr. Chairman.

Mr. **Volkmer**. Thank you.

Thank you very much, Mr. Shapley, for your testimony here today. You have been very helpful.

Our final witness today is Mr. John E. Naugle, senior director, Leasecraft programs, Fairchild Space Co., former Chief Scientist with NASA.

Mr. Naugle, your statement will be made a part of the record in full, and you may either review that in total or summarize, however you so desire.

[Answers to questions from Mr. Shapley follow:]

NATIONAL RESEARCH COUNCIL
COMMISSION ON ENGINEERING AND TECHNICAL SYSTEMS
2101 Constitution Avenue Washington, D.C. 20418

SPACE APPLICATIONS BOARD

(202) 334-3272

December 2, 1983

Honorable Harold L. Volkmer
Chairman
Subcommittee on Space Science
and Applications
U.S. House of Representatives
Committee on Science and Technology
Suite 2321
Rayburn House Office Building
Washington, DC 20515

Dear Mr. Volkmer,

Mr. Willis Shapley has prepared answers to the questions forwarded to him by your letter dated October 27, 1983 and has asked me to forward them to you.

Sincerely,

Milton W. Rosen

Milton W. Rosen
Executive Director

Enclosure

cc: George Harter
SAB Chairman

ADDITIONAL QUESTIONS FOR
MR. WILLIS M. SHAPLEY (SPACE APPLICATIONS BOARD)

Question 1: How would you characterize the health of the Space Applications program? Do our policies sufficiently recognize the link between our preeminence in space applications and technological leadership?

Response: I believe the Space Applications Board would characterize the health of the Space Applications Program as uncertain and even precarious. The NASA research and development program in space applications and the related programs for which NOAA is responsible are suffering because of the many unresolved uncertainties on the roles of the government and the private sector. As stated in my testimony, the projects now underway in communications (ACTS) and materials processing (McDonnell-Douglas) are in effect experiments, with uncertain outcomes, in ways the public and private roles can be sorted out. In earth remote sensing, the uncertainties are almost total, pending resolution of the issues on commercialization. With these uncertainties on the developmental, demonstration and operational aspects it becomes very difficult for NASA to plan and defend funding proposals for the continuing long term research and development program that is needed. The current funding levels appear to us to put the nation's future technological capabilities in civilian space applications in a precarious position. The Board has been especially concerned, for example, with the lack of funding in either the NASA or the NOAA budget to assure continuity is sensor development for meteorological satellites. It may be, as your question suggests, that our policies insufficiently recognize the link between preeminence in space and technological leadership. But general policies are unlikely to have much effect without clear decisions on the government's role and more adequate and consistent levels of budgetary support for the federal government's functions, including research and development.

Question 2: As you have indicated, the private sector cannot reasonably be expected to pay the full cost of test and demonstrations. Should we develop some standards or criteria which might be added to the NASA Act., so that relative cost contributions of government and the private sector could be anticipated?

Response: As indicated in my testimony, we believe that the situations in each of the areas of space applications need to be addressed separately in establishing the most appropriate pattern of federal and private support, and we are inclined to believe that establishing such patterns in general legislation rather than in annual reviews of specific program would most likely turn out to be overly inflexible. However, if some general standards or criteria of the sort suggested in your question are developed, we would be happy to review and comment on them if you wish.

Question 3: In some areas, there are not user communities for space technologies. How can, or should, the government build up a user group in such cases?

Are there models for technology transfer/utilization that NASA might follow? Could we use our field centers to bring together government, industry and university representatives to focus on problems of concern to the space technology community?

Response: The question of the government's role in building user communities for space applications is one where discussions in the Board have brought out a variety of considerations, some of which are not easily reconcilable. For example, there is a consensus, I believe, that in some areas it is a legitimate and necessary role of the federal government to sponsor tests and demonstrations by potential users. At the same time, it is generally recognized that the development of new user communities requires aggressive user-oriented marketing efforts which can generally be mounted most effectively by profit-motivated private concerns. It is a challenging problem to devise a pattern of federal-private sector relationships in which government sponsored demonstration programs do not undercut the opportunities for private entrepreneurs but actually encourage them. This is one of the problems that will be addressed in the study of institutional problems in the earth remote sensing field which the Space Applications Board is now undertaking. NASA's former "Technology Applications" program and other NASA-NOAA efforts to encourage the development of user communities provide models for consideration; whether any of the models would be applicable in the current situation is an open question at this time.

Question 4: There are two divergent pulls on the NASA Materials Processing program. On the one hand, some are urging more emphasis on commercialization and short term returns. Others are urging that more basic research be done to support future applications. Of course, we know this is not a black-and-white situation, for example we have indications that the McDonnell-Douglas electrophoresis work is on its way to success and should need little if any federally supported basic research. However, there may be other areas where more basic research is needed before we can hope to repeat or to generalize the McDonnell-Douglas success story.

a. Do you agree that there are some areas that could "pay off" if more research were done?

b. How could we best guide NASA in this area? Do we need any general guidance in the 1958 Act or can we do it through our annual authorization process?

c. Basic research tends to have a long payoff time. Is there a danger that if we try to guide it through the annual authorization process, we may try to oversteer the programs if we don't have some continuing guidance?

Response: The Space Applications Board has not recently made a detailed review of the current status of materials processing research and, therefore, cannot express a view at this time whether there are some areas that could pay off sooner if more research were done. As we have testified previously, our general view is that continued ground-based research supplemented by flight-testing in shuttle experiments is the proper course for NASA to take at this time. When specific likely "payoff" processes are identified, NASA should encourage one or more private concern to pursue them, using working arrangements like that with McDonnell-Douglas, if necessary. Unless there are known "payoff" items which are not being pursued, there does not seem to be any need for Congressional guidance other than normal monitoring of the research program and assuring the adequacy and continuity of funding.

STATEMENT OF DR. JOHN E. NAUGLE, FORMER NASA CHIEF SCIENTIST, AND DIRECTOR, LEASECRAFT PROGRAM, FAIRCHILD INDUSTRIES, INC.

Mr. NAUGLE. Thank you, Mr. Chairman and members of the committee. I think I will go through my testimony. It is fairly short.

I am pleased and highly honored to participate in these hearings to review the 1958 space policy act on this, the 25th anniversary of its enactment. I will make a short statement on the act itself and address two of the seven major issues the committee plans to address. I will discuss NASA's role in space science from the viewpoint of a former NASA Chief Scientist, and NASA's role in commercialization from the viewpoint of an industry executive in the process of establishing a commercial activity in space.

The 1958 space act was and still is an excellent statement of national space policy. Any superficial or detailed examination of the results we have achieved in space and the present status of our knowledge, technology, operating hardware, institutions, personnel, and management systems will attest to the soundness of that policy and the infrastructure it established. Certainly one result of your hearings should be a resounding tribute to the wisdom and foresight of those who originated the original act.

The space act has been for 25 years and is still a sound statement of national purpose and policy for aeronautical and space activities. It has a clear statement of our objectives, of the criteria to use to evaluate our progress toward those objectives, and the role of NASA and of the Department of Defense in space. The act gives the administration and NASA the flexibility they need to conduct their operations. It has stood the test of time, produced excellent results, and should not be changed.

NASA's role in space science is as crucial for the next 25 years as it has been for the last 25 years. There is no lack of vision in space science on the part of NASA or of this Nation's space scientists. They have solved many mysteries in the past 25 years but they have uncovered many more. There are missions under development or in study whose capability and complexity dwarf those missions which seemed so challenging only a decade ago.

I am, however, very concerned about the increasing time between scientific missions. Scientific research should be a continuous process. Scientists should be able to respond immediately to new discoveries or new ideas. Space science "packetizes" research because it has to be performed mission by mission. As long as each discipline had a new mission each year or two, this "packetization" could be accommodated. New ideas, new instruments, new discoveries would be incorporated in the program in a period of three or four years.

This is no longer the case. The period between missions is now 10 to 15 years. We cannot maintain our scientific leadership in an emerging, active discipline such as X-ray astronomy by flying an Einstein observatory in 1978 and then waiting 13 years until 1991 to follow up the discoveries of that mission with the advanced X-ray astrophysics facility. A nation cannot maintain a productive scientific community when scientists have to wait 10 years to explore a new discovery, test a new idea, or use a new instrument.

Ultimately we will solve this problem with the installation in space of permanent shuttle service facilities such as the space telescope, the advanced X-ray astrophysics facility, permanent platforms, and the space station. Once these facilities are in place, continuous observations will be possible and the shuttle can be used to place new instruments in operation every 2 or 3 years.

For the next decade, however, there is a real problem for which I know of no easy solution. There will be long gaps between missions. Funding for space science should be increased to keep the missions under development on schedule and bring the new facilities and missions such as AXAF, the upper atmosphere research satellite, and the venus mapper on line as soon as possible and reduce the long waiting period.

This can be done through the normal authorization and appropriation process, without changing the Space Act. I would compliment this committee and Congress for their actions in the fiscal year 1984 budget process, where you did add additional money to keep the space telescope on schedule and not make other missions suffer as a result of the technical problems that were encountered there.

There are two facets to NASA's role in the commercialization of space which should be treated separately Arranging for a commercial organization to take over the Government facilities and operations of the shuttle would be an example of commercialization of an ongoing Government activity. Undertaking a joint endeavor with a commercial firm to encourage and aid that firm in the production of a new product in space is an example of encouraging new commercial activity is space. NASA's role is quite different in these two cases.

In the first case NASA would have to be sure of an adequate market to sustain a profitable business, that the company is technically competent, has adequate financial resources, and that there is either sufficient competition or adequate regulation to assure a reasonable cost of transportation to and from space. Let me hasten to say that I do not think that the shuttle is ready to be commercialized at this time. NASA must continue to operate it for the foreseeable future.

NASA's role in establishing new commercial activities in space is quite different. Consider the essential requirements of a successful commercial activity: First, there must be a product which can only be produced in space or which can be produced in space so efficiently that it can compete with products produced on the ground. It must be a product which is extremely valuable in small quantities and for which there is a large market; by "large" I mean in excess of $100 million annually. There is a good deal of uncertainty, obviously, in that figure that I just gave you.

Next, there must be cheap, reliable transportation to and from space. If, for instance, you have a system in space which produces a pharmaceutical worth several hundred million dollars every 6 months, then you want to be very sure that you will be able to get that pharmaceutical back and into the market because every day's delay costs you money. The cost of that transportation must be as low as possible if you are to compete, and predictable several years in advance if you are to assure yourself of adequate return on your investment.

Finally, there must be a source of utilities in space, power to operate the system which produces the product, communications to control and monitor the process, and orientation to maintain a microgravity environment. I am obviously using here a case where you are producing a physical product in space. Another kind of product, obviously, is environmental research information, in which the product that you send down is information. The cost of these utilities must also be low and predictable several years in advance so that a potential space processor can know how much it will cost him to produce his product.

Fairchild is currently committed to a joint endeavor with NASA to produce large, mobile permanent shuttle-serviced platforms, built with private capital and placed in orbit to provide these utilities for commercial and government users. During the 12-year lifetime of our platform, which we call Leasecraft, we plan to change payloads, replenish expendables, and repair the platform if required, all on orbit. We plan to provide guaranteed services at guaranteed prices so our users will know several years in advance what their utility bill will be.

Fairchild is planning a commercial activity in space. In this case, our product is power, stabilization, communication, and payload space. What can and should NASA do to help start a commercial activity in space? The most important thing that NASA can do at this time is establish a reliable transportation system which carries people and material to and from space on schedule and at low and predictable prices. When we in Fairchild consider our own commercial activity, when we talk to our potential customers, and when we talk to our bankers, we find all our concerns focused on the need for cheap, reliable, regularly scheduled transportation to and from space whose costs can be projected at least 5 and preferably 10 years in advance.

There are, of course, many other things that NASA and the Federal Government can do to aid in the establishment of commercial activities in space, and there is a task force identifying these, but they are relatively insignificant compared to the need to turn the shuttle into something approaching a common carrier to and from space. Again, this can be done through the authorization and appropriation process and does not require change in the Space Act.

In summary, the 1958 Space Act was and is sound and should not be modified at this time. Space scientists are full of good new research ideas, but are suffering from a shortage of opportunities to put these ideas into practice. The most important thing NASA can do to encourage commercial activity is to reduce the cost and improve the reliability of transportation to and from space.

Thank you, Mr. Chairman, for this opportunity. I am prepared to answer questions.

[The prepared statement of Mr. Naugle follows:]

Statement of Dr. John E. Naugle
(Former NASA Chief Scientist)
Senior Director Leasecraft Program
Fairchild Industries Inc.

Before the
Subcommittee on Space Science
and Applications

of the
Committee on Science and Technology
House of Representatives

19 October 1983

Mr. Chairman, members of the Committee:

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X-ray Astrophysics Facility, permanent platforms and the space station. Once these facilities are in place, continuous observations will be possible and the shuttle can be used to place new instruments in operation every 2 or 3 years. For the next decade, however, there is a real problem for which I know of no easy solution. There will be long gaps between missions. Funding for space science should be increased to keep the missions under development on schedule and bring the new facilities and missions such as AXAF, UARS and the Venus Mapper on line as soon as possible and reduce the long waiting period. This can be done through the normal authorization and appropriation process without changing the Space Act.

There are two facets to NASA's role in the commercialization of space which should be treated separately. Arranging for a commercial organization to take over the government facilities and operations of the Shuttle would be an example of commercialization of an ongoing government activity. Undertaking a joint endeavor with a commercial firm to encourage and aid that firm in the production of a new product in space is an example of encouraging new commercial activity in space. NASA's role is quite different in these two cases.

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Finally, there must be a source of utilities in space, power to operate the system which produces the product, communications to control and monitor the process and orientation to maintain a micro-gravity environment. The cost of these utilities must also be low and predictable several years in advance so that a potential space processor can know how much it will cost him to produce his product.

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In summary, the 1958 Space Act was and is sound and should not be modified at this time. Space scientists are full of good new research ideas but are suffering from a shortage of opportunities to put those ideas into practice. The most important thing NASA can do to encourage commercial activity is reduce the cost and improve the reliability of transportation to and from space.

Thank you for this opportunity to testify.

Mr. VOLKMER. Mr. Naugle, we do have votes on. We will go for 5 minutes more. I will ask the gentleman from Florida if he has any questions before we recess, and we will return at approximately 4:20.

Mr. MACKAY. Not at this time, Mr. Chairman.

Mr. VOLKMER. Does the gentleman from Pennsylvania have any questions?

Mr. WALKER. Thank you, Mr. Chairman.

Just briefly, you say in the last part of your statement—and I thought you gave an excellent statement, particularly on the commercialization aspect—you say, at the end, that the Space Act is sound and should not be modified at this time. Would you have objections to language in the policy section of the act which would state that we ought to move toward commercialization, insofar as it is possible?

Mr. NAUGLE. I would have no objection to it.

Mr. WALKER. Again, not envisioning any major changes in the Space Act but simply stating that as a part of our policy option, Do you think that that would be a worthwhile addition to it?

Mr. NAUGLE. I think it would be a worthwhile addition, the sort of fine-tuning that Mr. Shapley talked about earlier, as an amendment or something of that nature.

Mr. WALKER. I thank you. That is all the questions I have, Mr. Chairman.

Mr. VOLKMER. The gentleman from Florida?

[No response.]

Mr. VOLKMER. I have a couple of questions. Maybe we can finish real fast and be on our way.

You said one of the biggest problems is the cost of the shuttle and the dependability. Do you have any suggestions as to reducing those costs?

Mr. NAUGLE. I wish I had concrete suggestions, Mr. Chairman. I think some of the things that NASA is doing, this new contract that they have put into place for the commercial handling of the shuttle operation at the cape is the sort of thing that helps.

It is equally important, Mr. Chairman, that those costs be predictable, which means that NASA and the Federal Government have to take a stand, "This is what it will cost you," because if you are considering investing several hundred million dollars into a commercial venture in space, then you want to know for sure or as sure as you can what you are going to have to pay for your transportation 5 or 7 years from now when you are actually in operation.

Mr. VOLKMER. Right now you do not have that specific assurance, because of NASA's proposals to change some of the costs.

Mr. NAUGLE. Well, NASA will give you costs only 3 years in advance.

Mr. VOLKMER. Right. How much lower would costs have to be to make the shuttle as a transportation system more viable for more commercialization?

Mr. NAUGLE. That is a difficult question to answer, Mr. Chairman. They really need to drive them down. If you consider the McDonnell Douglas electrophoresis process, where they have what I would call a leverage of a factor of 500 or 700 over that similar process on the ground, that is the kind of leverage that you have to have to produce a product that is viable in space, so anywhere between a factor of one-half down to a factor of 1,000 in reduction in those costs would be highly desirable. Now obviously they are not going to make that factor of 1,000 in the next decade or the next 15 or 20 years, but presumably 20 or 25 years from now you might think of really substantially reducing the transportation costs to and from space.

Mr. VOLKMER. On your Leasecraft, is it proposed to do one or the other? What I mean by that is basically to milk it, in other words, put it up there and leave it up there permanently for a period of years, and whatever is being processed in it, to bring that out and put new things in it; or is it planned to leave it up for 6 months or so and then bring it back and milk it here on Earth?

Mr. NAUGLE. No. Our plan is to put the Leasecraft in orbit and leave it there for periods on the order of 10 to 12 years, and use the shuttle to service it. It is modularized. We use the standard multimission spacecraft modules, so that if a power module goes bad you bring up a power module and exchange that. If an attitude control module goes bad, you change that. We are watching very keenly the solar maximum repair mission in the early part of next year, which will really demonstrate that what we are proceeding to do here has sound technical basis.

Mr. VOLKMER. At the present time, with the subsidized rates for the shuttle, do you see any problem with those shuttle costs as far as using the Leasecraft in the future when it won't be subsidized?

Mr. NAUGLE. Well, NASA needs to establish a policy, a pricing policy for the return of payloads from space. They have a firm policy for what it costs to take payloads into space. They are actively working, but they need to establish a policy of what the price is going to be to bring a payload back from space or material back from space.

Mr. VOLKMER. Would you like to comment—I know one of the other members who is not here is vitally interested, and since you are looking at transportation dependability and costs—would you like to comment on the need for a fifth orbiter or the nonneed for a fifth orbiter?

Mr. NAUGLE. Well, I am concerned about the number of orbiters. Four is a very finite number of spacecraft. On the other hand, NASA I know has considered that very considerably, and I am not prepared to take issue with their judgment on that.

Mr. VOLKMER. Thank you very much. I appreciate your being here, Mr. Naugle.

Before we recess or adjourn, I wish to ask unanimous consent that the statement of Manuel Lujan, the ranking minority member of the subcommittee, appear in today's record immediately following my statement.

The subcommittee will now adjourn. We won't be back. Thank you very much for being with us, Mr. Naugle. We will adjourn until 9:30 Tuesday for a continuation of the hearings.

[Whereupon, at 4:05 p.m., the subcommittee recessed, to reconvene at 9:30 a.m. on Tuesday, October 25, 1983.]

[Answers to questions from Mr. Naugle follow:]

Fairchild Space Company Germantown, Maryland 20874-1181 (301)428-6000

November 18, 1983
83:JN:152

The Honorable Harold L. Volkmer
Chairman, Subcommitee on Space
Science and Applications
Suite 2321 Rayburn House
Office Building
Washington, D.C. 20515

Dear Mr. Volkmer:

Attached are the answers to the questions for the record and the edited version of my testimony to the Hearings on Review of Title 1, Policy and Purposes, of the National Aeronautics and Space Act of 1958, which was held on Wednesday, October 19, 1983.

Sincerely,

John E. Naugle
Sr. Director
Leasecraft Program

JEN/cb
Attach.

Answers to Addition Questions

to John E. Naugle

1) Q. Do you believe our space science program is healthy enough to preserve the U.S. leadership role?

A. No, the seperation between scientific missions is much too long to maintain a first class scientific community.

2) Q. How can we break the cycle you describe whereby space science missions may be delayed for 10-15 years.

A. By increasing funding to accelerate the start of AXAF, SIRTF, SOT, UARS, and Planetary Explorers; by reducing the leadtime and cost of shuttle sortie missions and establishing permanent observations and platforms in space to permit the same type of continuous observations and rapid response to new discoveries as the ground based astronomers have.

3) Q. Do we need to make a stronger commitment to commercialization in space?

A. Yes, commercial activity requires regularly scheduled low cost transportation to and from space with tariffs established roughly 10 years ahead. Also essential is a commitment to the Space Station to provide a facility for hands-on R&D, pilot plant check-out and rapid transition from concept to commercial product.

4) Q. Do you believe if NASA expands its commercialization responsibilities, new institutional arrangements would be needed?

A. Yes, NASA should establish a "Commercial Affairs Office", similar in concept and responsibility to NASA's Office of International Affairs to provide a single point of contact in the agency and a rapid and uniform response to commercial initiatives and to encourage commercial activity.

Q. Should NASA be designated the "lead" agency for space commercialization?

A. NASA should be designated the lead agency for the "R&D technical activities" associated with space commercialization. NASA should not be assigned the "regulatory responsibilities". These should be assigned to DOC, DOT and/or STATE. NASA does not have the experience and infrastructure for this activity. In addition, assignment of this responsibility to NASA would diffuse and disrupt its badly needed National R&D-for-Space responsibility.

5) Q. Do you have any comment about the relative balance which should exist amont NASA's programs, or "missions"? Do you see any imbalances? For instance, some feel NASA's operational and potential commercialization activity may disrupt its R&D responsibilities.

A. So far, NASA has maintained a reasonable balance between science, exploration, application, space and aeronautical R&D work and its operational responsibilities for transportation and tracking and data acquisition. NASA's activities to further commercial activity should be regarded as an addition to these existing vital functions; additional funding and personnel should be allocated to the agency to further this important activity.

6) Q. Do you believe current space advisory and coordinating mechanisms for Federal space policy are adequate?

A. They were adequate when I left Federal Service in 1981, I have no knowledge as to their present adequacy.

Q. Should we consider recreating the National Aeronautics and Space Council to advise and coordinate Federal space/aeronautics activity?

A. I would use existing interagency coordinating mechanisms.

Q. Could Congress and NASA benefit from the establishment of an independent advisory board?

A. An independent board consisting of non-governmental personnel to develop and provide a commercial and academic view of commercial activity in space could be useful.

7) Q. A present, the "care and feeding" of some disciplines of space science -- for example astronomy -- is split between NASA and NSF. Neither agency is totally responsible for the "health" of astronomy. NASA thinks of itself as "mission-oriented". By this, they mean that they focus on individual missions to space. They do not mean for example that they have as part of their mission maintaining the health of astronomy.

Of course, I have picked astronomy as NSF as examples. I could have talked about study of the upper atmosphere being split between NASA, NOAA, ans NSF. And there are similar other splits.

a. Do you generally agree that the situation is as I have described?

b. You say things are working pretty well and we should not be thinking of "dismantling" the system. Is there anything we should do to the 1958 Act to improve things without dismantling?

A. NASA has a responsibility to insure an adequate academic and industrial base to support the national space activity. NSF has been responsible for ground based and NASA for spaced astronomy. In the past, there was close coordination between the two agencies insuring an adequate sound balanced national program in astronomy. The "Field Report" outlining a national program of astronomy, both ground and space based, is an excellent example of good coordination. Similar mechanisms should be used in any disciplines that have strong ground and space components. I do not see where changing the Space Act will improve the existing situation. First class scientists in responsible positions in the involved agencies capable of a statesmenlike non-parochial view of National needs in their disciplines is more important than legislation or formal coordinating committees.

8) Q. In your testimony you laid out the requirements for a space product to be successfully commercialized:

--Can only be produced in space
--Is extremely valuable in small quantities
--There is a market in excess of $100 million annually

8. How many materials have you been able to identify that now meet this rather stringent list of requirements?

A. Pharmaceuticals, crystals, and exotic metals are examples of materials which are valuabe in small quantities and have markets in excess of $100M annually, however, all of these are capable of being produced on the ground. The MDAC continuous flow Electrophoresis system is an example of a process which is several 100 times more efficient in zero-g than 1-g and a process which separates out a valuable pharmaceutical product with a potential large market.

I do not know of a process or product that is "unique" to space. We may have to wait until we do more research in zero-g to find such products or processes.

Q. How many do you think there may be by 1990?

A. My guess, Mr. Chairman, would be in the range of five to ten, I could easily be off by a factor of 2 either way.

REVIEW OF THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958

TUESDAY, OCTOBER 25, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Space Science and Applications,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:30 a.m., in room 2325, Rayburn House Office Building, Hon. Harold L. Volkmer (chairman of the subcommittee) presiding.

Mr. Volkmer. The subcommittee will come to order.

The Subcommittee on Space Science and Applications will continue hearings on the National Aeronautics and Space Act of 1958. Our first two witnesses today are veterans of the space program who have provided this subcommittee with valuable advice through the years.

We welcome today John Yardley, president of the McDonnell Douglas Astronautics Co. and former Associate Administrator of NASA.

Also joining us is Christopher Kraft, who just a year ago retired as the Director of Johnson Space Center. After 37 years involvement in the space program, I am sure Dr. Kraft will have some good advice for us today.

Helping us explore what might be involved on the financial end of space commercialization will be Jerome Simonoff, vice president of Citicorp Industrial Credit, Inc. Mr. Simonoff has been active as an advisor to OTA [Office of Technology Assessment] throughout its study on civilian space policy. He also currently serves as a member of the President's Task Force on Commercialization. This is his first appearance before our subcommittee.

Finally, we welcome Karl Harr, president of the Aerospace Industries Association. NASA would never be what it is today without its industrial partners.

We are glad you can join us today as we look ahead to NASA's next 25 years. I welcome all of you here today.

First, before we proceed with Mr. Yardley, I'd like to announce that we will have still photos and films of today's meeting by unanimous consent. With no objection, be it so ordered.

OK, we'll start with Mr. Yardley. John, you may proceed. Your statement will be made a part of the record in full and you may either review it in total or summarize, however you so desire.

STATEMENT OF JOHN YARDLEY, PRESIDENT, McDONNELL DOUGLAS ASTRONAUTICS CO.

Mr. YARDLEY. Thank you, Mr. Chairman.

I'm certainly pleased to appear before this subcommittee today and present my views regarding the future role of NASA. I'd like to begin by congratulating the Congress and this committee for developing the National Aeronautics and Space Act of 1958 which we are today addressing.

It has certainly served this country well and has resulted in the United States becoming the foremost Nation in this world in all aspects of space. We have indeed learned to sail on this new ocean, but, of course, the world changes, so it's entirely appropriate to review in this 25th year the appropriateness of this act as it stands for the next 25 years.

I have looked through the national objectives set forth in title I. My personal feeling is that all of these objectives are still applicable for the next 25 years, but we may want to add some new objectives regarding the economic development of space, either in the act proper or in separate legislation.

I'd like now to present some of my views on the major issues your subcommittee plans to address. First of all, NASA's role in the development and operation of future space transportation system. Those are sort of two separate questions: development is one and operation is another.

NASA, along with its contractors, has done an outstanding job of developing the world's best space transportation systems. I believe this should continue for the complex systems of the future. However, private enterprise should be permitted and encouraged to contribute portions of the transportation systems of the future where they feel conditions are favorable and appropriate for their investments.

This is already occurring, as evidenced by the current expendable launch vehicle commercialization policy, and by the use of private upper stages, such as our McDonnell Douglas payload assist module, and others under development.

So, in summary, NASA should remain, in my opinion, the primary developer of sophisticated complex transportation systems of the future. The question of whether NASA should be the operator is a more difficult one.

Many feel that a sophisticated R&D organization like NASA cannot operate in an efficient manner and we should, therefore, give the operation to someone else who is not hampered with the desire to continually improve the system, but who will operate it simply and efficiently.

My feeling is that there is a grave danger of real catastrophy if we completely separate the R&D organization from the operation organization. I feel the best solution for the next decade, at least, is to leave the operations responsibility with NASA, but to perhaps internally reorganize to have some greater separation between the operation and the R&D arms than exist today.

With regard to NASA's role in space applications, I believe it should be basic research in areas that private enterprise is not yet willing to make substantial investments. NASA should be doing the far-out research to provide the seeds that industry can build on to grow into significant economic developments to aid the entire country.

It should also be NASA's responsibility to actively involve the private sector, to help them with development, generally assist them in bringing space products to market. NASA is doing most of these at the present time. For example, they have what is called the joint endeavor agreement where they work with private industry, primarily providing launch services, while private industry does the actual development work. And this is a very good program.

But we need more involvement of other Government agencies to speed the potential economic development of space businesses. The Space Act may be a proper instrument to state policy in this area, but appropriate legislation may also be required elsewhere. Areas of importance are many, and include such things as export tax law, tax incentives, proprietary protection, and the multiplicity of Government agencies who have partial regulatory responsibilities in space activity.

Just as a digression, it came as quite a surprise to me when, during our meeting with the President a few weeks ago, Jack Townsend stated that when he launched Leasat, the IRS interpretation was that was an export and he was not allowed to take R&D tax deductions. The President was absolutely astounded. But there are many of those types of things that need to be counted.

One of the most important areas to the potential space entrepreneur is that of stable, long-term Government policies in the launch areas of cost, services rendered, priorities, capacity, and so forth. New space businesses require great financial risks in unproven technology, unknown markets and so forth. Most new commercial products will require 8 to 12 years before any net profits are realized.

Most of the private firms who would normally manufacture similar products on Earth are not used to depending on the Federal Government for a substantial portion of their needs. Without a firm, long-term Federal policy supported by the Congress and the executive department and backed up by significant deeds, most of these people will feel the risks are too high and the space businesses will languish.

New Space Act language setting this long-range policy, together with authority to permit NASA to contract on long-term, multiyear bases for launch and other services, including liability for failure to perform, would go a long way toward solving this problem. It wouldn't necessarily have to be in the Space Act, but it should be in the law.

I also feel a major Federal Government action is needed to demonstrate sincerity and long-term commitment. The most appropriate action, in my opinion, would be a space station commitment backed by multiyear funded appropriation.

With regard to NASA's role in national security, their present role of providing results of research and newly developed technology should continue. The role of launch vehicle operator, which many people view as a new one to NASA, is not really new. NASA has been launching military payloads, particularly communication payloads, on the Delta and Atlas Centaur for many, many years.

However, the shuttle does bring a new dimension in that it will launch substantially all military payloads, maybe a few exceptions, but the military is really dependent on the shuttle; whereas it has not been that dependent in the past.

To split the shuttle operations into civil and military parts would be very costly, at least at the present time. The day may come when the amount of traffic and the number of orbiters can decrease the cost, but at the present time, it certainly would be costly to have two separate operators.

If the military took over the system, I believe the commercial use of the shuttle would be stunted, if not destroyed. I, therefore, think we should continue the current system where NASA acts as the military's launch agent for the shuttle.

An additional comment, if the shuttle were operated by a commercial organization, I think that would be totally unacceptable to the DOD. I don't mean in the sense that they work for NASA; I mean as a private operator.

Regarding NASA's role in commercialization and technology transfer, I believe NASA should be the lead agency in facilitating commercialization and technology transfer to the private sector in all space activities in the same sort of manner that I outlined above with respect to space applications. However, I do not think that they should become the regulators of this activity.

With regard to enhanced international cooperation and competition, NASA should lead the space aspect, the overall Federal policy in these areas, much as they have done in the past and they've done a good job. I think the Apollo-Soyuz was a good example. Spacelab is another one.

They do need, though, to have a heightened awareness of U.S. economic interests as they pursue these policies. There is often a fine line between cooperation and competition and you have to understand what's going on in the commercial world.

NASA's role in space policy formulation should be that of a major participant when the United States is formulating space policy. They shouldn't have the final say, but they should certainly be heard. They should be the principal advocate for advancing space technology and space commercialization.

In conclusion, I would like to reiterate that the Congress and NASA have done an outstanding job in the last 25 years with the existing Space Act. The current policy should be retained and new ones be added stressing NASA's roles in the economic development of space.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Yardley follows:]

STATEMENT
OF
JOHN F. YARDLEY
PRESIDENT
MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

Mr. Chairman and Members of the Subcommittee:

I am pleased to appear before this subcommittee today and present my views regarding the future role of NASA.

I would like to begin by congratulating the Congress for developing the National Aeronautics and Space Act of 1958. It has served this country well, and has resulted in the United States becoming the foremost nation in the world in all aspects of space. We have indeed learned to sail on "this new ocean."

The world changes, of course, so it is entirely appropriate to review the Space Act to see if those wise policies developed 25 years ago are still the best for the next 25 years. In reviewing the national objectives set forth in Title I of the Space Act, I think all of these objectives are still applicable for the next 25 years, but we probably need to add some objectives regarding economic development of space.

I would like now to present my views on some of the major issues the Subcommittee plans to address:

- NASA's role in the development and operation of future space transportation systems.

NASA, with its contractors, has done an outstanding job of developing the world's best space transportation systems. I believe this should continue for the complex systems of the future, but private enterprise should be permitted and encouraged to contribute portions of the systems when they feel conditions are appropriate for their investments. NASA is currently doing this, as evidenced by the expendable launch vehicle commercialization policy, use of private upper stages such as McDonnell Douglas Payload assist module, etc. The question of whether NASA should be the operator is a more complex one. Many feel that a sophisticated R&D organization like NASA cannot operate in an efficient manner, and we should therefore give the operation to someone else who is not hampered with the desire to continually improve the system, but will simply operate it efficiently. My feeling is that there is a grave danger of catastrophy if we completely separate the R&D organization from the operation organization. I feel the best solution for the next decade is to leave the operations responsibility with NASA, but to internally reorganize to have some greater separation than exists today.

- NASA's role in space applications.

I believe NASA's role here should be basic research into areas that private enterprise is not yet willing to make substantial investments. It should also be NASA's responsibility to actively involve the private sector, to help them with development, and generally assist them in bringing space products to market. NASA is doing all of these things at the present time (e.g. Joint Endeavor Agreements), but needs more involvement of other government agencies to speed the potential economic development of space businesses. The Space Act may be a proper instrument to state policy in this area, but appropriate legislation may also be required elsewhere. Areas of importance include export tax law, tax incentives, proprietary protection, and the multiplicity of government agencies who have partial (fragmented) regulatory responsibilities in space activity.

One of the most important areas to the potential space entrepreneur is that of stable, long term government policies in the launch policies of cost, services, priorities, capacity, etc. New space businesses require great financial risks in unproven technology, unknown markets, etc. Most new commercial space products will require eight to twelve years before any net profits are realized. Most of the private firms who would normally manufacture similar products on earth are not use to depending on the federal government for a substantial portion of their needs. Without a firm long term federal policy supported by congress and the executive department and backed up by deeds, most of these people will feel the risks are too high, and the space businesses will languish. New Space Act language setting this long range policy, together with authority to permit NASA to contract on long term multi-year bases for launch and other services (including damages for failure to perform) would go a long way toward solving this problem. I also feel a major federal government action is needed to demonstrate sincerity. The most appropriate, in my opinion, would be a space station commitment backed by a multi-year funded appropriation.

- NASA's role in national security.

NASA's current role of providing results of research and newly developed technology should continue. The role of launch vehicle operator is also a traditional one (Delta and Atlas Centaur have launched many military payloads over the years). The Shuttle, however, does bring a new dimension, in that it will launch substantially all military payloads. To split the Shuttle operations into civil and military parts would be very costly. If the military took over the system, I believe the commercial use of the Shuttle would be stunted, if not destroyed. I therefore think we should continue the current system where NASA acts as the military's launch agent for the Shuttle.

- NASA's role in commercialization and technology transfer.

NASA should be the lead agency in facilitating commercialization and technology transfer to the private sector in all space activities similar to that described in space operations above, although they should not become the regulators of this activity.

- NASA's role in enhanced international cooperation and competition.

NASA should lead the space aspect of the overall federal policy in these areas, much as they have done in the past. They need to have a heightened awareness of United States economic interests, as they pursue these policies.

- NASA's role in space policy formulation.

NASA should be a major participant in the formulation of United States space policy. They should be the principal advocate for advancing space technology and space commercialization.

In conclusion, I would like to reiterate that the Congress and NASA have done an outstanding job in the last 25 years with the existing Space Act. The current policies should be retained, and new ones should be added stressing NASA's roles in the economic development space. Thank you, Mr. Chairman.

Mr. Volkmer. Thank you, Mr. Yardley.

At this time, I wish to welcome the chairman of the full committee, Hon. Don Fuqua, from Florida, here to the hearing and at this time, I will recognize him for any question he may have.

Mr. Fuqua. Thank you, Mr. Chairman, and let me join in welcoming our good friend, John Yardley, back here again. He spent many dedicated years at similar tables like that up here in some crucial years of the shuttle program, so we are glad to have you back, John.

One of the questions that came to mind, and you touched on it in your concluding remarks, was that NASA should be a major participant in space policy. Do you think they are today?

Mr. Yardley. Well, I'm a little out of touch with precisely——

Mr. Fuqua. Well, you can be like a former Governor we had in Florida. After he left office, he said, now that he was out of office, he could tell the truth. [Laughter.]

Mr. Yardley. I guess I don't think they have as significant a role as I believe they should have. They are a participant. I think they're viewed, though, by the rest of the participants as advocates and, therefore, are not listened to as well as they should be.

Mr. Fuqua. How would you propose that that could be changed? Is there a structural change that needs to be made? For instance, we had the Space Policy Group at the White House that was abolished during the administration of President Nixon. Was that a proper vehicle or did that serve that purpose? He felt like it was almost useless at that time and that's why he abolished it.

Mr. Yardley. I really can't say that it really was much different than what we see today. Today we have senior interagency groups, but if you look at the one for space, for example, its makeup is not greatly different than what we used to have on the old Space Council——

Mr. Fuqua. Space Council, yes.

Mr. Yardley. You get the feeling the deck is stacked because you've got so many other agencies for which space is kind of a nuisance. You've got one that may be really pushing for it and I don't know what the structural change is unless you give NASA three votes instead of one vote or something. [Laughter.]

Mr. Fuqua. Well, you also have the problem that—I guess is an inherent problem of human nature, but some of these other groups that sit at that table don't want to put any money into it, even once it becomes operational. They're reluctant to commit any of their funds because they're trying to protect long-term bureaucratic turf and projects that they have. There's never enough money to go around.

Mr. Yardley. Yes, and then there's the other aspect some of them feel that if NASA gets their space money, they'll lose something.

Mr. Fuqua. Yeah.

Mr. Yardley. And I'll put some of our scientists in that category, some of the DOD in that category, too. I don't have the answer to that, but it's a good question.

Mr. Fuqua. I think it is, too, and I appreciate your candid comments about it. Good to see you again.

Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you. The gentleman from Pennsylvania, Mr. Walker.

Mr. WALKER. Thank you, Mr. Chairman.

You made a number of references in your remarks to the commercialization aspect and I think made some very valuable comments about that. I've been particularly interested in how we might respond in the Organic Space Act to the commercialization advent and in your mind, would it be helpful to put some language into the policy section of the Space Act indicating that it should be one of the roles of NASA to spin off to commercialization insofar as possible those things which have been proven through research and development.

Mr. YARDLEY. I would maybe even go farther and make it one of NASA's objectives to plan the space program to give the most economic benefit from space to the United States, however that might be structured.

Mr. WALKER. So in other words, as far as you're concerned, language like that maybe doesn't go far enough. You—you—you think that we need to have, though, some statement within the Space Act which at least acknowledges that there is a role for NASA in the commercialization sector.

Mr. YARDLEY. Absolutely. Otherwise, they're fair prey for the hatchets over in OMB whenever they try to do something useful.

Mr. WALKER. You said that, in your statement, the Space Act does need modified, but do you think there is enough leeway in it operationally at the present time to allow most of these commercial activities to take place without major changes in the act itself?

Mr. YARDLEY. There is no question the act, as it sits today, will permit almost anything. It was a well-constructed act. The question is, does it give NASA enough push and enough clout in their infighting with the rest of the Federal Government to really get things done?

Mr. WALKER. I think that's the important point and so—in other words, language on commercialization should be such that it gives NASA the ability to go to other agencies and basically go to the country as a whole and say, "One of our roles is commercialization. We have to have the financial support, the ability to carry out that particular part of our mission as defined by this change in the Space Act."

I thank you very much and thank you, Mr. Chairman.

Mr. VOLKMER. Thank you and I recognize the gentleman from Florida, Mr. Nelson.

Mr. NELSON. Thank you, Mr. Chairman.

It's good to have you back, John. Could you elaborate on your comments that we shouldn't turn the launch operations over to some other outside-of-government operation?

Mr. YARDLEY. OK, that's a long subject. I'll make it short in summary. If you had a consortium of people that had the money to buy the shuttle from the Government and all the services, all of which is probably never going to happen, but if it could somehow be done, then the Department of Defense would be wholly, or almost wholly, dependent on this commercial organization for their space services. This is kind of analogous in my mind to the Navy selling all their ships to a private enterprise and then sort of having them operate the Navy for them. It's just not a practical approach from the DOD's point of view.

Now, I don't think the DOD really likes NASA doing it for them, either, but that's the lesser of evils. So that would be my number one point.

The other point is, there is something like $15 billion of sunk costs in the system. The cost pricing structure is not making any profit. It may in years to come; I don't know, but to make that a totally commercial deal where somebody pays $15 billion up front, they're going to go broke.

It's sort of like the national highways and everything else. So I think those two reasons are the main reasons that we shouldn't do it. In terms of trying to streamline the operations and getting single responsible prime contractor for shuttle processing, like NASA is doing down at the cape, is a step toward that, but it's still a NASA operation.

Mr. NELSON. That's correct. Now, let me take it one step further. You certainly do support the commercialization, if there is a market there, of expendables; is that true?

Mr. YARDLEY. I have mixed emotions on that. It's sort of like your mother-in-law driving over the cliff in your new Cadillac. My company makes the most popular, successful, expendable launch vehicle, the Delta. On the other hand, I am not planning on commercializing it and the frank reason is that it would cost 30 percent more than the same service on the shuttle. Point No. 2 is it's rapidly becoming obsolete in size for the communication market, so I don't have any objection to it. But I don't think the market is going to amount to anything in that area, except in upper stages, things of this sort.

Mr. NELSON. As we start to commercialize, if that does become a reality, and that you have an ongoing enterprise where there are expendables and that they are owned and operated by private enterprise and that there is this market out there to launch and so forth, it has been proposed that this kind of activity be directed from a government agency other than NASA. Do you have any comment about that?

Mr. YARDLEY. I'm not sure I understand. If you mean——

Mr. NELSON. Responsibility.

Mr. YARDLEY [continuing]. Regulated.

Mr. NELSON. Regulated. Regulated, operated by an agency other than NASA, specifically the Department of Commerce. Do you have any comment about that?

Mr. YARDLEY. I haven't given a whole lot of thought to who ought to be the regulator. I don't think it ought to be NASA, but it should be an agency that has most of the activities within itself. Right now you have to go four or five different organizations in the Government to get approval to launch.

Somehow, we need to pull that together, whether it's in Commerce or DOT or wherever.

Mr. NELSON. Now, why do you—don't—why don't you think that ought to be NASA?

Mr. YARDLEY. Well, I think that you're going to get into regulatory functions and I just don't think that's appropriate for an agency that does mostly R&D and operations.

Mr. NELSON. Do you think another agency ought to be out there in the midst of NASA and the Air Force?

Mr. YARDLEY. You're talking about private, commercial launch operations. NASA's not going to fly in unless their life depends on it——

Mr. NELSON. But they're going to——

Mr. YARDLEY. The military isn't, either.

Mr. NELSON. Aren't they going to be out there on the cape using those facilities?

Mr. YARDLEY. Yes. They're going to lease them.

Mr. NELSON. You think that that can compatibly be done with another agency of Government without NASA and its finger in it?

Mr. YARDLEY. NASA doesn't have to have an operational function at the cape; that's all Air Force land.

Mr. NELSON. Well, the Air Force—my opinion is, we've seen such a very good and symbiotic working relationship between NASA and the Air Force and if people who say NASA ought to be an R&D agency, but NASA also is an operational agency——

Mr. YARDLEY. Yes, I thought we were talking about regulation, though.

Mr. NELSON. Well——

Mr. YARDLEY. To the extent that they need some to assist commercial operators in some services, sure, NASA ought to be involved in that, if it makes good sense right now. On the Delta, NASA provides services to the Delta pad. They wouldn't have to. One could get those services from the Air Force, but they're NASA—it's NASA's launch vehicle. So they could do that.

Mr. NELSON. Let me——

Mr. YARDLEY. That wouldn't be a major responsibility, other than any other Government agency that was servicing a private organization.

Mr. NELSON. Let—let me shift directions here just a second and go back to a statement that you had made earlier. You said you had mixed emotions about commercialization of expendables. It implied in your concern the concern of what might happen to an orbiter fleet as to whether or not it gets to be developed as you—as one of the fathers of this shuttle program—as you initially conceived it?

Mr. YARDLEY. I really don't think that's a major concern. I made a rough estimate on that about 6 months ago. I had NASA's pricing data and, of course, I know what the Delta pricing data is and if, let's say, floated the shuttle price up to the expendable price, and if Ariane floated up, too, I estimated the worst case would knock 10 percent off the shuttle's traffic. It's not, you know, a really significant swinger.

Mr. NELSON. All right. I'll ask——

Mr. YARDLEY. But I don't want the shuttle price to go up 30 percent because I fly on the shuttle for other things.

Mr. NELSON. Let me ask one more question. I know we have to go vote. Do you think there will be those in OMB and other agencies of the Federal Government who will use commercialization of expendables as a reason not to go to a fifth and sixth orbiter?

Mr. YARDLEY. That's very possible. They'll certainly use it in the arguments and frankly, I think that right now, any commercial entrepreneur that takes an existing launch vehicle and tries to compete with the shuttle is doomed to failure.

Now there may be places where that's not the case, David Hannah is talking about a small scout-type vehicle for certain specialized purposes. The shuttle can't really compete at that small a payload, so he may have a market there, but there are going to be specialty niches, not existing vehicles, I think.

Mr. **Nelson**. Thank you, Mr. Chairman. I'm——

Mr. **Volkmer**. Yes, I'd like to proceed. I have a couple of questions, John, if I can finish, we'll go to the next witness when we get back, after the vote, but if not, I'll ask you to stay for a little bit.

I notice that in the shuttle operations on page—I think it was page 1 of your statement—you state that you "feel the best solution" of this is in the shuttle itself—in the last sentence—"for the next decade is to leave the operations responsibility with NASA, but internally reorganize to have some greater separation than exists today."

I'd like to read to you some statement by the task force, National Advisory Council on the mission of NASA, page 7. They say:

> The new task force recommends that a new NASA organization be created at the appropriate time within NASA to focus on shuttle operations and utilization, including marketing activities, sustaining engineering support. This organization, which would be headed by a deputy administrator, should have fenced manpower, finances, and facilities basically to separate that part of NASA—

The shuttle operations, distinct away from the space, I mean science parts, the R&D, et cetera.

Do you generally agree with that statement?

Mr. **Yardley**. Well, it sounds like it may be a little too separated. You've got to carefully balance, in my opinion, the operator's ability to do what which he needs to do to operate properly without having to be the victim of too many engineers making too many changes.

On the other hand, he's got to have that technical expertise because this is a very sophisticated machine and, if you cut it off too hard and lose this technical expertise so that he doesn't have access to them, then you're inviting trouble. So, to do it with within those described boundaries sounds a little strong.

I think you've got to have some double duty between the R&D engineers, who are working on something new, but who should be available to work problems as they arise. I don't know if it's possible if you separate it that hard.

I'd be interested when Dr. Kraft gets up here of his opinion on that, because he's worked closer to that than I have.

Mr. **Volkmer**. Well, earlier testimony last week—Mr. Fink had testified in regard to it and supported this concept. Of course, he is chairman of the task force and supported the concept and I thought that I'd ask you on that.

I have—also I find intriguing your statement on the multiple year funded appropriation. Of course, you know we are in 1-year cycle in our appropriations. The only way I see possibly to do that is to fund it without—by saying it could be expended, you know, in future years, not put the requirement that it be expended in that fiscal year.

But on the other hand, I see, because of fiscal constraints here, you get into the space station, I don't think we're going to be able to get several billion dollars appropriated in 1 year for the space station to be expended over a period of several years. I don't think that's going to happen.

Mr. **Yardley**. It may not be easy, but I have confidence in you gentlemen. [Laughter.]

Mr. **Volkmer**. Well, I think we got that OMB looking at us again. That's part of the problems.

I have several other questions I would like to ask. I'm going to have to recess now for the vote and come back. I'll return at——

Mr. **Yardley**. Fine.

Mr. **Volkmer** [continuing]. 10:25 and recess until 10:25.

[Recess.]

Mr. **Volkmer**. The subcommittee will resume its sitting.

John, on page 2 of your statement, you also recommend language that would permit multiyear contracting on a multiyear basis by NASA for certain services and launching. Can you elaborate on reasoning on that?

Mr. **Yardley**. Yes, sir. When these private entrepreneurs take on the development risks of new products from space, one of their big costs is launch services. They're not going to make any profit for 10 years. So if they can't predict what that launch cost is going to be in 10 years, they're not going to take the financial risk.

So what I'm saying is that it doesn't have to be a constant rate; if he can be given a price of what it's going to cost he can then contract that way regardless of other policy changes. That's what I'm saying.

Mr. **Volkmer**. All right. Thank you very much.

Before I proceed with—Mike's not here, all right. I thought the gentleman from Texas was here. I have a couple more questions.

Now, it appears that your company's program on electropheresis is well on its way to success. We only hope so. There may be other areas, of course, we feel that more basic research is needed before we can repeat your materials processing in space.

Do you agree that we need to do further research in the total area——

Mr. **Yardley**. I certainly agree that NASA should have a well thought-out program of basic research in the areas that would lead to space products. By space products, I mean products that can be made best in space and can be sold at lower prices than the equivalent product produced on Earth. Or you just can't get the product, which is the case in our electropheresis pharmaceutical products. It just can't be made on Earth.

So if NASA had a program whereby they carry basic research to a certain point and then have industry pick it up for development and assess the risks and invest the money, I think that would go a long way toward facilitating a more rapid growth of the economic benefits of space.

Mr. **Volkmer**. And do you feel that perhaps we should amend the 1958 Space Act to do it, or do you feel it's necessary?

Mr. **Yardley**. Well, I don't know——

Mr. **Volkmer**. Put more emphasis on——

Mr. **Yardley**. I don't know that it's necessary to amend the act. The act certainly has enough flexibility to do it. I think some form of congressional and executive words would be desirable. Perhaps authorizations act, perhaps appropriation acts; I don't know. But some emphasis should be in NASA's charter to actively involve the private sector for the economic well-being of the whole country.

Mr. **Volkmer**. In this area of materials processing or antigravity manufacturing, whatever you want to call it, is there any way you feel that NASA could do more than they're doing so far—except for electropheresis? There seems to be the question of push and pull and there doesn't seem to be too much of the pushing at the present time among industry, manufacturers, et cetera. Should we continue on with the pulling process?

Mr. **Yardley**. I think so. Let me give you a couple of thoughts on why I think it's slow to develop. Most of the products that could be made in space are made by companies which are not in aerospace and have no desire to work with the Government. They don't know it exists. Anytime somebody asks, "Why don't you get into this and work with the Government," they throw up their hands. It's a risk that they just don't think they can take and so we've got several things that need to happen.

The Government has got to demonstrate some significant support for long-range policy statements, perhaps change the Space Act. This would include contracting so that these new businesses can be guaranteed what it's going to cost them as they go through the development and manufacturing process. We've got to have some educational processes which can be done by NASA or perhaps with some consultants. There are some very good consultants that can get this community of people who have space products together with aerospace companies who know how to build space hardware and know how to work with NASA.

That cycle has got to be accelerated. Some people would call it marketing on NASA's part. I like to think of it as educational activity, that is to get the foremost types of product manufacturers involved, and then have policies that will relieve their anxieties about getting halfway through a new business and having the shuttle price double or the services have diminished.

Mr. **Volkmer**. One last question. You have touched on the shuttle—putting us in the forefront in leadership in space as far as transportation systems. Do you have any ideas on how we can basically reduce that cost on the STS?

Mr. **Yardley**. Well, of course, the recent step that NASA has taken in terms of consolidating contracts at Kennedy is one step which I hope will lead to some lower costs. I think basically the learning process will bring those costs down quite a bit. Our learning curves on building external tanks; processing solid motors and orbiters are bringing those costs down, if our projections that we made a few years ago, and they're still being projected, come true, those prices are going to continue to go down for another 5 or 6 years.

Mr. **Volkmer**. Then you would not agree that—let's say, in 1986 or 1987, if we go to a full-cost recoupment on launches that it will lead to a doubling in prices?

Mr. **Yardley**. I don't think so. As a matter of fact, I've looked at NASA's projections and it so happens that the cost—projected for, I believe, 1988—is actually slightly lower than they have declared it for the 3 years preceding.

Mr. **Volkmer**. All right. I want——

Mr. **Yardley**. Whether they'll be able to make it or not, we're not sure.

Mr. **Volkmer**. All right. I have no further questions. I want to thank you very much, John, for being here with us today. You've been very helpful in our deliberations.

Our next witness will be Dr. Christopher Kraft, former Director of NASA/Johnson Space Center.

Chris, your statement, too, will be made a part of the record and you may either—be in the record in full—and you may either review [illegible] statement in full or summarize, however you so desire. Appreciate your being here today.

[Answers to questions from Mr. Yardley follow:]

Box 516, Saint Louis, Missouri 63166

JOHN F. YARDLEY
PRESIDENT

(314) 232-9906

29 November 1983
E002-JFY-498

Honorable Harold L. Volkmer, Chairman
Subcommittee on Space Science and Applications
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Subject: Additional Questions Pertinent to the 25 October 1983 Hearings on Review of the National Aeronautics and Space Act of 1958

Dear Mr. Chairman:

I have reviewed the subject questions and find that all but four have been suitably answered in either my statement or the subsequent oral questions.

My answers to the other three questions are as follows:

2. If NASA's responsibilities in the commercialization area expand significantly, how do you see this affecting the agency's R&D mission?

ANSWER

I feel that NASA could substantially expand their responsibility in the commercialization areas of research and development and facilitation of users without affecting their R&D mission. I feel that they should avoid a regulatory role which would not be compatible with their R&D activity.

4. We are seeing increasing militarization of space, as plans for a new space weapons research program are revealed. The President's science advisor has said that funding for such a program may be drawn from existing R&D programs.

   a. What does this mean for our civilian space program, and NASA?

ANSWER

I don't see any reason for the Department of Defense requiring NASA funding to increase their space weapons research program.

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c. Do you think the space act as currently written is sufficiently clear in its delineation of responsibilities between NASA and DOD?

ANSWER - Yes

5. How would you characterize the health of NASA's space applications program? Do our policies sufficiently recognize our preeminence in space applications and technological leadership? If it is not healthy, what would bring it back to life?

ANSWER
I would characterize the health of NASA space applications program as poor, primarily because of decisions made several years ago to deemphasize space applications. I believe it should be revitalized with additional funding, particularly in the area of space material processing basic research, so that it can support a strong space commercialization program.

Sincerely,

MCDONNELL DOUGLAS CORPORATION

John F Yardley

John F. Yardley
President
MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

JFY:skw

STATEMENT OF CHRISTOPHER C. KRAFT, JR., FORMER DIRECTOR, NASA/JOHNSON SPACE CENTER

Mr. **Kraft**. Thank you, sir.

I'd like to say at the outset that I enjoyed Mr. Yardley's presentation and I'd like to also say that I didn't realize he'd learned that much in his short tenure in the Government. [Laughter.]

I believe the advancement of the U.S. space program under the NASA has been as rapid and as productive as ever achieved in our country's history, and while I suppose that you could get as many opinions as witnesses as to the reason for that success, I offer you the reason for mine, and it is a very simple one.

NASA, in both its aeronautical and space activities, offers the scientists and engineers it employs the unparalleled opportunity to contribute to the growth of our country. This is done in an extremely wholesome atmosphere of commitment to national goals and allows the country and the world to see its results, whether they be successes or failures.

The prime motivators are the satisfaction of accomplishment and the everyday knowledge that one is contributing to the future of the United States, as well as all free men and women. The importance of this open environment to the tremendous success of NASA cannot be overemphasized, cannot be overlooked when considering future organizational matters, and the preservation of this very delicate state should be of grave concern to this subcommittee and, indeed, the entire Government body.

The subcommittee has selected a number of topics to analyze during this session. Quite a few of these topics are very complex and require considerable understanding in order to arrive at reasonable and good answers. However, none of these is more important or more pertinent to your deliberations than the one I have just described.

Probably going to say some things here now that at least are personal opinion and one from experience in NASA, but at least they are what I felt as I lived in NASA. The character of NASA, and therefore, the leadership in space activities during the last decade, has undergone a subtle but definite change.

As this committee well knows, the NASA has been under great pressure by every administration since the lunar landing to reduce these expenditures, while at the same time, it has been criticized by the Congress and others for its lack of vision for failing to expand its goals. These conflicting pressures from the Nation's leadership create an unwholesome environment for effective administrative action. It resulted in NASA cloaking both its problems and its desires.

I don't mean to imply that the NASA Administrators have tried to hide their problems from the administrations they served, but because they realized the delicacy of the situation, they were afraid that insistence on hard commitments might well lead to the loss of what little they had.

Predictably, this budget pressure of the mid-1970's created the unhappy inquisition at the hands of Congress and others in Government in the 1978 time period and I don't need to say any more about that subject here.

I just wanted to give the committee a feel for the atmosphere that existed over the past decade and then explain the results. NASA actually abdicated its leadership role in laying out the course the Nation should follow in spending its space dollars.

Into this vacyoum flowed the persuasive arguments of a number of groups, both inside and outside of Government, who sought to influence or control the future of the Nation's space program. NASA did create a compendium of space goals under Dr. Don Hearth in 1976, but this document, though well done, did not spell out a course of action to be followed.

In my opinion, there are now so many people in the act that it is very difficult for the administration and Congress to make good decisions on what the United States should do in space. I have stated the problem as I see it and now what should be done about it?

If at all possible, the NASA responsibilities for creating an agenda for the U.S. space program should be restored. The Government should make it very clear that NASA is expected to produce such a plan and that those seeking Government expenditures or support must coordinate their efforts through NASA.

I speak here of a civilian space program as differentiated from the military or national security requirements, realizing that these two programs require close coordination and cooperation. However, I believe that NASA and DOD have the organizational mechanisms in place that can assure this process.

The NASA plan should be a projection of what the Agency foresees as reasonable and responsible goals to be achieved in both the near and far term, updated annually to reflect budget limitations, past accomplishments, new developments and changes brought about by the Nation's needs.

I know some will argue that this process is already being pursued, but believe me, it is at best a sporadic and unreliable process. The research establishments and the industry are in sore need of a clearly defined planning process. These groups and others wishing to contribute to the Nation's space program need to have this kind of planning to insure an orderly course.

The important point is that NASA should be in a position to describe where we are going. It will be up to the administration and Congress to determine the rate at which it will be accomplished. This process would then allow the industry of the country to make its plans with confidence that the plan created has strong possibilities of being carried out.

There is, of course, a need for commitment by the administration and the Congress to assure that the NASA plan is supported within the context of the priorities created by the budget process.

There has been a great deal of debate in recent months regarding the future operation of space transportation system. That is, should the shuttle be operated by the Government or should it be spun off to be owned and operated by some industry team?

To begin with, the STS is a national asset developed with tax money and before it's given away—at least I, as a citizen, would say—one must deal with the uses it will be put to and the profit or loss to be made, and eventually the return on investment made by the taxpayer.

The shuttle, because of its versatility, has great military, as well as scientific uses. Although the DOD has shown some reluctance in committing its future to the—in space to the STS, there's no doubt in my mind that a great proportion of the future military space operations will be conducted using the space shuttle system.

When you then consider that the future NASA space station activity will also be dependent upon the STS, as will other NASA R&D projects, it is apparent that the Government will continue to be intimately involved in the detailed technical and operations management of the STS.

The traditional role of the aerospace industry in supporting the Government—Government in its space activities will certainly be required, but I believe it is neither practical nor desirable to turn the STS over entirely to some commercial venture.

Perhaps a number of years from now when the DOD is independently operating and conducting its own space shuttle activities, as it most certainly should, and the NASA has moved its operations from an Earth base to a space base, one might reconsider this question.

However, until this expansion in space activities has taken place, I believe it is in the Government's interest to maintain detailed control of the STS. Cooperative ventures with allied governments would seem to dictate the same conclusion. In fact, I would recommend that a joint NASA/DOD program office for STS management be seriously considered in the very near future.

To further expand on the debate of the STS versus expendable launch vehicles, I would offer the following: The one sure way to make the STS cost effective, as in any transportation system, is to increase its load factor and assure that it is flying as often as the fleet size will allow.

Let's suppose for a moment that we could manage the STS as we would any new business venture of a similar magnitude. I think we would do everything possible to maximize our customer base and increase the number of uses of the STS. Certainly we would not consider encouraging other businesses to compete by subsidizing their modest investment in expendable launch vehicles.

I realize the Government wants to encourage private industry to enter the space business, and so do I, but the dilemma this poses suggests that these private enterprise proposals need further study. I give some further thoughts there on what I think might be done.

The growing potential for space products is a result of private-sector confidence that the zero gravity environment provided by STS and a space station will stimulate the development of important new technologies and commercially viable products. Because of this enthusiasm, a disturbing sentiment has been voiced within the OMB that in essence says, "If the industry is so interested in space, why aren't they willing to pay for it?"

Any approach that would relieve the national budget is admirable, however this suggestion is not only naive, but very damaging to the future uses of space. The investments that would be required of industry to offset NASA's present budget problems are far greater than any single industrial organization or an industry group could provide.

Moreover, this approach represents a total repudiation of the policy of Government-industry cooperation so desperately needed by our country today. We have the benefit of history to guide our course. The expansion of the West via the railroads, the air transport industry, the Interstate Highway System, all required continuing Government investment and the U.S. economy has benefited enormously from it.

Return on the taxpayer's investment defies measurement. I don't know this, but I'd almost be willing to bet that there were arguments for not making these investments over the past 200 years, which would sound very much like those advanced relative to space.

I do know this, however, our position in the world economy is heavily indebted to America's dominance of aviation. That preeminence has been possible only because of the Government's continuing investment in aeronautical technology, the research and development done by NACA and NASA over the past 60 years. This same kind of Government investment in space is absolutely essential to protect America's future position in world markets.

As an engineer and administrator for the past 35 years, I have been privileged to participate in the greatest technological advancement in our Nation's history. It is extremely difficult for me to listen to the current debate over NASA's proposal to build a space station. The opposition of this proposal by science groups, budgetary specialists, and other learned individuals mystifies me. It is hard to believe that these people have lived through the last 25 years totally oblivious to what has been going on.

If you would indulge me, I'd like to discuss these past 25 years of progress in space and the effects on our national growth. The decade of the sixties was a time of technological rejuvenation in the United States, driven to a great extent by the implied threat of the Russian Sputnik and the responding U.S.-manned space program.

The challenge to our technical strength and our patriotic responsibilities of landing men on the Moon and returning him to safely to Earth was the dominant factor in the development of a whole new set of technologies in every field, including medicine. The results of these advancements in the state of the art are epitomized by the communications satellite and the microelectronic explosion that created today's computer technology.

To say that the prosperous technological advantage the United States possessed in the late sixties and early seventies was driven solely by the space program would be presumptuous, but to say it would not have happened without the space program is undeniably true. The point I want to make is not that this country and the world flourished on the technology of the sixties—that is self-evident—but that we consumed it in the seventies and failed to make the R&D investment necessary to repay that consumption.

In truth, what happened was that our world economic competition eagerly took our sixties technology, improved on it, and added to it. Now in the early eighties they are beating us at our own game.

I must remind you here that the space shuttle was not, and was never intended to be a technology driver. We made a conscious decision to build a space transportation system with 1972 technology. That was one of the strong selling points, to build a reusable launch vehicle and provide rapid and easy access to the space environment without having to provide a lot of new inventions.

In 1983, going to and from space is not a technology driver. It is what you can do in space after you get there that can fuel a mighty resurgence in U.S. technological leadership and the payout will be measured in significant contributions to both the gross national product and balance of payments.

In my opinion, the research and experiments conducted in space will bring about a whole new set of products and processes in space and on Earth, not unlike the technology development of the sixties Space-based research facilities provided by the Government will form the basis for industrial expansion into space.

In my scenario, these facilities will initially provide for cooperative work with the academic community and industry, eventually evolving into a space operations base for industrial use similar to the seaports and airports here on Earth. The space base will allow unlimited expansion of the use of space at a number of altitudes, including geosynchronous and in time, a way station for Lunar base operations and other planetary exploration.

Indeed, the next generation in space communications and the eventual determination of the practicality of space-based powerplants will be dependent upon the development of these orbit—Earth-orbiting stations.

But even if an early commitment is made to proceed with the development of a space station, the hiatus of the past 10 years will have its effect. We need a bridge between our extremely limited present on-orbit stay time and the initial operational availability of a space station.

I would encourage the development of an STS orbiter with extended mission capability to meet this interim need. The budgetary support would not be great and the benefits to be gained would contribute directly to the operational phase-in of a space station. We could hit the ground running. An additional benefit would be the revitalization of the academic and industrial research capability which we—will be needed to support such a program.

Gentlemen, I would conclude that the NASA charter established in 1958 has served the country extremely well. I see no need to change it. The need of the eighties is a renewal of commitment on the part of the U.S. Government to assure that the Nation gets a full measure of benefits from the Space Act.

I believe these hearings are timely and proper and it is time to take stock.

[The prepared statement of Mr. Kraft follows:]

Statement by Dr. Christopher C. Kraft, Jr. before the Subcommittee on Space Science and Applications, Committee on Science and Technology

I believe the advancement of the U. S. Space program under the NASA has been as rapid and as productive as has ever been achieved in our country's history. And, while I suppose that you could get as many opinions as witnesses as to the reason for that success, I offer you the reason for mine - it is a very simple one: NASA in both its aeronautical and space activities offers the scientists and engineers it employs the unparalleled opportunity to contribute to the growth of our country. This is done in an extremely wholesome atmosphere of commitment to national goals and allows the country and the world to see its results, whether they be successes or failures.

The prime motivators are the satisfaction of accomplishment and the everyday knowledge that one is contributing to the future of the United States as well as all free men and women. The importance of this open environment to the tremendous success of NASA cannot be overemphasized - cannot be overlooked - when considering future organizational matters; and the preservation of this very delicate state should be of grave concern to this subcommittee and indeed the entire Government body.

The subcommittee has selected a number of topics to analyze during this session. Quite a few of these topics are very complex and require considerable understanding in order to arrive at reasonable and good answers. However, none of these is more important or more pertinent to your deliberations than the one I have just described.

The character of NASA, and therefore the leadership in space activities, during the last decade has undergone a subtle but definite change. As this committee well knows, the NASA has been under great pressure by every Administration since the Lunar landing to reduce its expenditures, while at the same time it has been criticized by the Congress and others for its lack of vision - for failing to expand its goals. These conflicting pressures from the Nation's leadership created an unwholesome environment for effective administrative action; it resulted in NASA cloaking both its problems and its desires. I don't mean to imply that NASA Administrators have tried to hide their problems from the administrations they served, but because they realized the delicacy of the situation they were afraid that insistence on hard commitments might well lead to the loss of what little they had. Predictably, this budget pressure of the mid-'70s created the unhappy inquisition at the hands of Congress and others in Government in the '78 time period. I need not say more about that subject here; I just wanted to give the committee a feel for the atmosphere that has existed over the past decade and then explain the results.

NASA actually abdicated its leadership role in laying out the course the Nation should follow in spending its space dollars. Into this vacuum flowed the persuasive arguments of a number of groups both inside and outside of Government who sought to influence or control the future of the nation's space program. (NASA did create a compendium of space goals under Dr. Don Hearth in 1976, but this document, though well done, did not spell out a course of action to be followed.) In my opinion, there are now so many people in the act that it is very difficult for the Administration and Congress to make good decisions on what the U. S. should do in space. I have stated the problem as I see it. Now, what should be done about it?

If at all possible, the NASA responsibilities for creating an agenda for the U. S. space program should be restored. The Government should make it very clear that NASA is expected to produce such a plan and that those seeking Government expenditures or support must coordinate their efforts through NASA. (I speak here of a civilian space program as differentiated from the military or national security requirements, realizing that these two programs require close coordination and cooperation. I believe that NASA and DOD have the organizational mechanisms in place that can assure this process.) The NASA plan should be a projection of what the agency foresees as reasonable and responsible goals to be achieved in both the near and far term, updated annually to reflect budget limitations, past accomplishments, new developments and changes brought about by the nation's needs. I know some will argue that this process is already being pursued, but believe me, it is at best a sporadic and unreliable process. The research establishments and the industry are in sore need of a clearly defined planning process. These groups and others wishing to contribute to the nation's space program need to have this kind of planning to assure an orderly course. The important point is that NASA should be in a position to describe where we are going; it will be up to the Administration and Congress to determine the rate at which it will be accomplished. This process would then allow the industry of the country to make its plans with confidence that the plan created has strong probabilities of being carried out. There is, of course, a need for commitment by the Administration and the Congress to assure that the NASA plan is supported within the context of the priorities created by the budget process.

There has been a great deal of debate in recent months regarding the future operation of the Space Transportation System. That is, should the Shuttle be operated by the Government or should it be spun off to be owned and operated by some industry team? To begin with, the STS is a national asset developed with tax money and before it's given away, one must deal with the uses it will be put to and the profit (or loss) to be made and, eventually, the return on investment made by the taxpayer.

The Shuttle, because of its versatility, has great military as well as scientific uses. Although the DOD has shown some reluctance in committing its future in space to the STS, there is no doubt in my mind that a great proportion of the future military space operations will be conducted using the Shuttle system. When you then consider that the future NASA space station activity will also be dependent upon the STS as will other NASA R&D projects, it is apparent that the Government will continue to be intimately involved in the detailed technical and operations management of the STS.

The traditional role of the aerospace industry in supporting the Government in its space activities will certainly be required, but I believe it is neither practical nor desirable to turn the STS over entirely to some commercial venture. Perhaps, a number of years from now when the DOD is independently operating and conducting its own Space Shuttle activities - as it most certainly should - and the NASA has moved its operations from an Earth base to a space base, one might reconsider this question. However, until this expansion in space activities has taken place, I believe it is in the government's interest to maintain detailed control of the STS. Cooperative ventures with allied governments would seem to dictate the same conclusion. In fact, I would recommend that a joint NASA/DOD program office for STS management be seriously considered in the very near future.

To further expand on the debate of the STS versus expendable launch vehicles, I would offer the following: The one sure way to make the STS cost effective, as in any transportation system, is to increase its load factor and assure that it is flying as often as the fleet size will allow. Let's suppose for a moment that we could manage the STS as we would any new business venture of a similar magnitude. I think we would do everything possible to maximize our customer base and increase the number of uses of the STS. Certainly we would not consider encouraging other businesses to compete by subsidizing their modest investments in expendable launch vehicles. I realize the Government wants to encourage private industry to enter the space business, and so do I, but the dilemma this poses suggests that these private enterprise proposals need further study. NASA, with help from the aerospace industry - private venture capital organizations - and an organization such as the National Academy of Engineering, could analyze the costs and benefits of encouraging continued private sector involvement and present their findings to the Administration and the Congress with a suggested course of action. In any event, I do not favor extended subsidization of these companies because it will stunt the growth and use of the STS at a time when all elements of our country should be encouraged to take advantage of it.

The growing potential for space products is a result of private sector confidence that the zero gravity environment provided by STS and a space station will stimulate the development of important new technologies and commercially viable products. Because of this enthusiasm, a disturbing sentiment has been voiced within the OMB that in essence says, "If the industry is so interested in space why aren't they willing to pay for it?" Any approach that would relieve the national budget is admirable; however, this suggestion is not only naive but very damaging to the future uses of space. The investments that would be required of industry to offset NASA's present budget problems are far greater than any single industrial organization or industry group could provide. Moreover, this approach represents a total repudiation of the policy of government/industry cooperation so desparately needed by our country today.

We have the benefit of history to guide our course - the expansion to the West via the railroads, the air transport industry, the interstate highway system - all required continuing Government investment -- and the U. S. economy has benefited enormously from it. The return on the taxpayer's investment defies measurement. I don't know this, but I'd almost be willing to bet that there were arguments for not making these investments over the past 200 years which would sound very much like those advanced today relative to space. I do know this, however: our position in the world economy is heavily indebted to America's dominance of aviation. That preeminence has been possible only because of the government's continuing investment in aeronautical technology - the research and development done by NACA and NASA over the past 60 years. This same kind of Government investment in space is absolutely essential to protect America's future position in world markets.

As an engineer and administrator for the past 35 years, I have been privileged to participate in the greatest technological advancement in our nation's history. It is extremely difficult for me to listen to the current debate over NASA's proposal to build a space station. The opposition to this proposal by science groups, budgetary specialists and other learned individuals mystifies me. It is hard to believe these people have lived through the last 25 years totally oblivious to what has been going on. If you would indulge me, I'd like to discuss those past 25 years of progress in space and the effects on our national growth.

The decade of the '60s was a time of technological rejuvenation in the U.S. - driven to a great extent by the implied threat of the Russian Sputnik and the responding U. S. manned space program. The challenge to our technical strength and our patriotic responsibilities of landing man on the Moon and returning him safely to Earth was the dominant factor in the development of a whole new set of technologies in every field including medicine. The results of these advancements in the state of the art are epitomized by the communications satellite and the microelectronic "explosion" that created today's computer technology. To say that the prosperous technological advantage the U. S. possessed in the late '60s and early '70s was driven solely by the space program would be presumptuous - but to say that it would not have happened without the space program is undeniably true. The point I want to make is not that this country and the world flourished on the technology of the '60s - that is self-evident - but that we consumed it in the '70s and failed to make the R&D investment necessary to repay that consumption.

In truth, what happened was that our world economic competition eagerly took our '60s technology, improved on it and added to it. Now, in the early '80s, they are beating us at our own game. I must remind you here that the Space Shuttle was not and was never intended to be a technology driver. We made a conscious decision to build the Space Transportation System with 1972 technology - that was one of the strong selling points - to build a reusable launch vehicle and provide rapid and easy access to the space environment without having to provide a lot of new inventions.

In 1982, going to and from space is not a technology driver. It is what you can do in space after you get there that can fuel a mighty resurgence in U. S. technological leadership. And the payout will be measured in significant contributions to both the Gross National Product and the balance of payments. In my opinion, the research and experiments conducted in space will bring about a whole new set of products and processes, in space and on Earth, not unlike the technology development of the '60s. Space-based research facilities provided by the Government will form the basis for industrial expansion into space. In my scenario, these facilities will initially provide for cooperative work with the academic community and industry, eventually evolving into a space operations base for industrial use similar to the seaports and airports here on Earth. The space base will allow unlimited expansion of the use of space at a number of altitudes, including geosynchronous; and, in time, a way-station for Lunar base operations and other planetary exploration. Indeed, the next generation in space communications and the eventual determination of the practicality of space-based power plants will be dependent upon the development of these Earth-orbiting stations.

But even if an early commitment is made to proceed with the development of a space station, the hiatus of the past ten years will have its effect. We need a bridge between our extremely limited present on-orbit stay time and the initial operational availability of a Space Station. I would encourage the development of an STS orbiter with extended mission capability to meet this interim need. The budgetary support would not be great and the benefits to be gained would contribute directly to the operational phase-in of a Space Station; we could "hit the ground running." An additional benefit would be the revitalization of the academic and industrial research capability which will be needed to support such a program.

Gentlemen, I would conclude that the NASA charter established in 1958 has served the country extremely well. I see no need to change it. The need of the '80s is a renewal of commitment on the part of the U. S. Government to assure that the Nation gets a full measure of benefits from the Space Act. I believe these hearings are timely and proper. It's time to take stock.

Mr. **VOLKMER**. Thank you very much, Dr. Kraft. I have several questions that go to earlier parts of your statement.

One of them has to do with space policy and developing a space policy. Do we need more advisory committees or is the current apparatus, do you think, sufficient in order to help develop that space policy?

Mr. **KRAFT**. Well, I—I believe that space policy is a tough thing to come by in terms of satisfying all people, and everytime I've seen one of these policy efforts obtained, it comes out with what I would consider less than—than what should be accomplished by the resulting organizations within the Government.

I think the problem, as I see it, is the way I stated it, that we've got so many people trying to tell us what we ought to do at this moment that it's very difficult for committees such as yourself, and particularly the administration and OMB, to figure out what they ought to do, and I believe that if you try to do that in all the other elements of Government, you would result in similar type chaos.

I give you as an example the FAA. I happen to be on an advisory committee for the FAA and I would praise them very highly for the national aerospace plan that they have, and they—they've got a plan laid out; they spell it out very carefully and I think the general aviation and commercial aviation now is beginning to realize what they're up to and how it's going to affect their future in operating airplanes in this country, and I think it's a super idea.

I think that NASA ought to be deriving a similar type plan for space. I believe it can be done. I don't think that it's a tough job to do. I think anybody that's been in the space program can almost point out what we—what you should be doing for the next 30 years and almost predict what's going to happen from it.

Mr. **VOLKMER**. In other words, set out goals in the science and space applications, et cetera, for periods of years and not just——

Mr. **KRAFT**. Not only goals——

Mr. **VOLKMER** [continuing]. Not by project.

Mr. **KRAFT**. I think the Government's main objective here is to provide the tools upon which the science and other organizations in industry can make their own plans, and I think they will, but right now, I think they're concerned that they don't know which way we're going to go. They don't know when we're going to build a space station or even if we're going to build a space station. They don't know whether we really intend to operate at geosynchronous altitudes, either manned or unmanned.

I think people need to know that that's our game plan and then the industry will backfill that as they see the opportunities develop and as NASA provides research in a very similar manner that NACA has done it in the last 50 years.

Mr. **Volkmer**. On the question of STS operations, I asked John Yardley the question regarding setting up within NASA an organizational structure separately funded; everything would be fenced off, as the NASA Advisory Council recommended earlier this month.

Do you have an opinion as to that type of a structure for the operation itself?

Mr. **Kraft**. My statements would be almost identical to what John had to say and I was smiling back there—when you get comments from people who make such statements, you can realize that they never did it. Those are the people that don't have to do it and it sounds like a great idea that we ought to separate this thing off and we ought to have all these separate people and—separate everything and that's a great idea from an organizational scheme and it can't work because you need the technical competence of the—of the NASA organization to maintain the direction of the space transportation system and it—it's going to continue to have technical issues that must be solved, and you're going to have to depend on those people that have the technical know-how to do it.

I think NASA already has to some extent a separate organization in that regard and I—whatever is best from a—from a financial situation ought to be provided to NASA in order to get a separate budget if that helps them and help separate it from the R&D efforts. I'm certainly in favor of that, but trying to say that you ought to—to take this organization and separate it from everybody—everything else that's going on in NASA is naive. It—it will never be that way and it—it will fall flat on its face unless you keep the technical people involved.

Mr. **Volkmer**. In other words, you can't operate the shuttle yet like you would a fleet of airplanes that have already been developed and——

Mr. **Kraft**. Indeed, you can, and I——

Mr. **Volkmer** [continuing]. In operation?

Mr. **Kraft** [continuing]. I—I'm not sure you ever will. I hope you will, but I think that, as John says, I think it will take a long time for that to develop and the—we're just—we're in the embryo stages. We don't even know what we're going to use the Space Shuttle for yet and certainly the military is going to use it. They've got to use it. It has too much potential, too much capability. We can't ignore the great benefits to be—to be gained in the Defense Department, and that's the reason I spoke as I did about a joint program office between NASA and the DOD.

Mr. **Volkmer**. Yeah, I'd like to get into that. What would be the advantage of that type of office, having a DOD and NASA—joint management office?

Mr. **Kraft**. I think that NASA would always take the lead from a technical point of view because they have the technical capability and they have the know-how. However, I believe that the—the Department of Defense would feel a lot closer to the uses of the space shuttle to—for the things that we—were being carried out, both from a financial and technical management, if they felt like they played a part in the operation of that machine.

Certainly, they are going to use it very quickly in the next 10 years and I think if they were a part of that management, they'd be much more likely to utilize its virtues than—rather than look at it as something that they're continuously trying to fight their way in.

So I believe if the—if the Chief of Staff of the Air Force, for instance, had a general officer who was a deputy to Mr. Loni in Houston, Tex., that they would find it a much more palatable operation and—and would be more in love with the space transportation system than they are today.

Mr. VOLKMER. All right. To continue on, basically with the space transportation system—you also mention in regard to the space station, the need to have one of the orbiters modified so that it can have extended orbit, more than the 9 or 10 days that we presently have.

Some of us have discussed whether, if we get into that, what impact is that going to have on the ability of the system in the 1991 or 1992 or 1989 timeframe, to continue on and provide sufficient number of orbits and operations to sustain the commercial and the defense needs, as well as do those things that are preparatory to the space station?

Then if we do have a space station, we're going to have to use that orbiter to take things up to the space station, et cetera.

In other words, what I'm looking at is, is our four-orbiter fleet going to be sufficient when we get into that timeframe? Do you have any comments on that?

Mr. KRAFT. There are a lot of comments on that, sir. In the first place, four-orbiter fleet is nowhere near enough to carry out the traffic that's going to be taking place in the 1990's for the demands on both the commercial uses and military uses, so it's inconceivable to me that we're going to shut down the orbiter line and not build more because we will be very sorry for having done that. The demands will be there.

Mr. VOLKMER. In your opinion, we should start on a fifth right away, then?

Mr. KRAFT. My opinion—we should never shut down the orbiter line. I think what we ought to do is find out what is the way—best way from both an economical and a budget point of view, realizing that those two are conflicting sometimes, to keep the orbiter line open so that the Government would have the choice and the opportunity to get more orbiters whenever they decided they needed them and the traffic requirements were there.

On the other hand, I can't, sir, I can't just emphasize to you too much, any more than I tried to say in my paper, that the real need of this country is technology. We need technology. The only way we can compete in this world economic situation is to have the upper hand in technology on the rest of the world, and we've got to have some drivers.

And those drivers, in my opinion, are going to come a great deal from what we can accomplish in space. These are going to drive a whole new set of industries, a whole set of technologies, and we need to get on with the development of those technologies.

We can't wait 10 years to build a space station, and that's how long it's going to take us, so we need to have something to bridge the gap. We've got this machine which can—which, by the way, everybody has forgotten the fact that we designed the orbiter to have 30-day capability. It's designed to have that capability. It was in the original specifications. There is no big deal to making it have that capability. It doesn't take an expenditure of a lot of money.

Mr. VOLKMER. If we did decide to go ahead with the fifth orbiter, that could be made with the provision for the modification——

Mr. KRAFT. Very easily and there's no reason why that fifth orbiter, if the traffic demands require it, couldn't be used at a later time to carry that traffic. It can be—it has a dual purpose, so we must get on with the development of this technology.

Mr. VOLKMER. Now, in that, discussing technology, we've had testimony during these hearings for the Office of Technology Assessment that with the increased funding and progress of space programs with the military, that we'll probably run into difficulties as far as having qualified manpower to provide for our civilian uses if—in other words, we get into the space station simultaneously with the increased military programs.

Do you have any comment on that?

Mr. KRAFT. The legacy of Apollo is that the country can do anything that it sets its mind to do, regardless of what it is. I speak at a lot—the only place I will—that I will accept a speaking engagement these days is at a university. I like to go there and it keeps me out of the public eye, which a lot of people would just as soon stay out of. [Laughter.]

And frankly, those young men who are out there are more worried about whether they're going to have a place to go and a place to work than they are about the statement you just made about not having enough people to do it. If the young people of this country—and they grew up with space, they are really our future and they believe in it—if they—if they knew this plan that I described was going to be carried out in this country and that there was a great future in space, you would see people flocking to the universities to take the courses necessary to provide them the education to get there.

So I think that's a real bugaboo. I think that if we in this country show the—the youth that we believe in technology, that it's necessary and that we are going to have a strong space program, you'll have more than enough people to take on the task.

Mr. VOLKMER. That concludes my questions.

Does the gentlemen from Florida, chairman of the full committee, have any questions?

Mr. FUQUA. Thank you, Mr. Chairman.

Chris, we're happy to welcome you back here and you made many contributions from the very beginning of the space program and on through the shuttle, so you have been part of all of it.

I notice—maybe the question has been asked—I was looking at your testimony before I had to leave and go to another meeting.

Unfortunately, we have several meetings going on at the same time.

Mr. **Kraft**. Yes, sir.

Mr. **Fuqua**. You were talking about the many people that are in the act makes it difficult for the administration and Congress to make good decisions on what we should do in space. You heard me ask John Yardley almost a similar type of question.

What—what do you think needs to be done about it?

Mr. **Kraft**. Well, somehow we've got to get the ball back in NASA's court. Right now, there are so many different organizations that the administration in particular depends upon to give them advice that they're—they're getting almost conflicting stories or they're getting special-interest groups requirements or they're being confused by the fact that the DOD now is going to make space a place to create war, et cetera, et cetera.

The NASA charter states that they are responsible for developing the country's efforts in space and I think that ought to be reemphasized. People ought to know that NASA is the place where you go to get your—to make your inputs. Now I don't mean that they shouldn't be open to debate on any—any subject, as it should be in this country, but NASA should be looked at as providing the space plan and I mentioned while you were out that the FAA has a—has a terrific plan these days on the national airspace—national air system, and I think that NASA ought to have a similar plan for what we're going to do in space for the next 20 to 30 years, and it's not tough to come by.

I don't say that we ought to go out and give them a blank check. You're not going to do that, but at least people would know the directions that we were going in and people therefore in the industry can make the right plans to back that up and do what their part of the problem is going to——

Mr. **Fuqua**. How do we—I know what the problem is, too, I think. My concern is how do you fix it? We find that—and you mention the Hearth study. We had a review in the midseventies about—it was about the 20th year of NASA at that time or somewhere in that neighborhood—we were looking ahead and we made some recommendations.

When you get administration people up here, they can't even talk about anything other than the current-year budget because of the constraints that OMB and the administration—it's not this administration, it's all administrations——

Mr. **Kraft**. Yes, sir.

Mr. **Fuqua** [continuing]. It's an inherent bureaucratic entanglement that we find ourselves in and the NASA Administrator, the people that can speak for NASA are hogswaggled in what they can say.

They can't do long-range planning, like for 10, 20 years of a master plan because somebody's afraid that it may cost some money and where's the money coming from? A lot of pressures are involved. I agree, we need to do that very badly. We have pushed NASA to try to come up with a long-range plan and invariably they want to come up with it but then somebody puts a silencer on them before they can make it public.

There were bills—the National Space Policy Act—pending. Senator Schmidt had a bill similar to that. We had bills in our committee similar to that, but sometimes we can't even get them to comply with the current law.

I don't mean that NASA is trying to defy the law; it is because people, other people and outside influence over them, prevent them from doing that. It makes it very frustrating to come up with a long-range policy, as you talked about. I'm making my speech about it, rather than a question, but I am concerned about how do we—how do we break that——

Mr. **Kraft**. I think you ought to force them to come up with such a plan. I think that there probably ought to be some—if necessary, a law that says, that requires NASA to—to promote such a plan. It doesn't have to be a budgetary plan.

Mr. **Fuqua**. Right.

Mr. **Kraft**. The budgetary process can be different from that plan, but at least people will know the direction that NASA wants to go in, and the problem with the Don Hearth study was it was just a total compendium of what everybody thought you could do in space for the next 100 years. What you need to do is require a plan that says, "This are—these are the directions we're going to go in. These are the—the actual tools that we need to do our job with so that the outside world, as you have said very plainly needs—can figure out where the country is going."

That's what the FAA has done in the—in the last 20 years and I—I'm very pleased. I just started on an advisory committee to the FAA yesterday and I am very pleased with that kind of process and I don't see why you can't—why the administration of NASA cannot do the same thing. I think they should.

Mr. **Fuqua**. Well, they come up with——

Mr. **Kraft**. And it's not a dreambook——

Mr. **Fuqua** [continuing]. Plans periodically——

Mr. **Kraft** [continuing]. I'm not talking about a dreambook; I'm talking about what should the country do in hard-nuts work of getting the job done.

Mr. **Fuqua**. And where are the priorities?

Mr. **Kraft**. Yes, sir.

Mr. **Fuqua**. Similar to the Space Science Board that comes up with certain recommendations, but that—that really has no official stamp of the agency, and from year to year, we're fighting, and the agency's fighting.

Mr. **Kraft**. And I think it's going to take the administration and the Congress to pull this thing back into bounds and say to everyone concerned, "OK, you got all kinds of ideas here about what should be done." Now take those to NASA.

We've given NASA the responsibility to come up with this plan. They're going to come up with it and then we'll give you the opportunity to criticize it or say it's empty or whatever or it's too grandiose, whatever, but at least NASA would be responsible for taking that plan and then taking the comments on the plan and through other directions of the administration and Congress, saying, "Well, we want changes made to that plan in the following way."

Mr. **Fuqua**. I agree with you and thank you very much for being here.

Mr. **Kraft**. Thank you, sir.

Mr. **Volkmer**. Now recognize the gentleman from Texas, Mr. Andrews.

Mr. **Andrews**. Hello, Dr. Kraft.

Mr. **Kraft**. How are you, sir?

Mr. **Andrews**. Good to see you again. I bet no member of this committee has had more constituents testify than I have, from Sally Ride to Chris Kraft. It's really good to see you again.

I'd just like to ask you, in following up the chairman's comments and questions if historically, for those of us that are new to the committee, and new to the space program, you could expand a little bit on what happened back in the midseventies. How did we get to the spot where NASA, as you say, abdicated its leadership role? What happened within NASA that changed that and what resulted in, I suppose, the 1976 study by Dr. Hearth that's just really goal-oriented without any specific agenda in terms of financing the program?

What happened within NASA to change that and evolve to where NASA abdicated its role?

Mr. **Kraft**. I don't know whether I can say that in as few words as necessary here, but I'll try. I think that in the midseventies as we began to get to the point where the space shuttle was not being provided the moneys that were necessary to maintain its momentum, we were—we were short about, I'd say about 10 to 15 percent per year. We had a handshake with the Office of Management and Budget on a fixed-price contract for the space shuttle which was, in my opinion, ridiculous in the first place.

Any time you do an R&D program of that size and then take on what was—amounted to a fixed-price contract, was very difficult to do. Now, to the—to the betterment of NASA and its management and people like John Yardley, we were able to keep the program under budgetary control and keep it from—from going into some unstable situation where it was going to get out of bounds from a cost point of view.

Irrespective of that, we were not getting the money that was necessary to maintain the momentum of the program and it was obvious to all of us that we were building a bow wave out in front of us that it was eventually going to get us to the point where we'd either have to stretch the schedule or make it known that we just didn't have enough money to meet the schedule.

Now, I think that—that the Administrators of NASA at that time, and rightly so, could see that the—the atmosphere, the environment that they were living in in Washington was going to prevent them from getting those dollars necessary and so they were trying to be wise in their thinking and saying, "Well, we can't get this amount of money out of the administration this year. They've got so many other priorities; we've got so many problems in the country. We just can't go in and tell them that we need another $150 million this year."

And NASA, until 1978, I think was the date, never had a supplemental—almost every other organization in the—in the Government asked for a supplemental every year. NASA had a policy, "We won't ask for supplementals." It was a precedent we don't want to set.

Now, that got them into a point—a place where they were getting continuously behind the eight ball and they realized that they were going to have to slip this program. They thought it was in the best interest of the country to slip it, rather than force the issue because they felt that they did force the issue, that that would create a spotlight on NASA and they might, indeed, lose as much as they had, and it would be cut even further.

So I think that they were trying to make the political budgetary and technical judgments over all that would put them in that position. Now, I don't criticize them for that; I'm just merely pointing out that that was the situation existed, but as a result, because they were reticent to stand up and say what should be done in space and the fact that we were falling behind and the fact that we ought to have more technology, and the fact that we ought to be planning to take advantage of the STS when we get it.

We got to the point where there were too many other organizations that then began to flow into the vacuum to say what should be done and that clouded the issue. Anytime that happens, that clouds the issue because you've got too many people who are particularly interested in—in science in one place or technology in another place or aeronautics in another place and it gets diluted and that, to me, is the situation that happened.

Now, I could go on and explain to you what happened with Mr. Carter and the SALT talks and the demands of the shuttle and the fact that we couldn't slip it because of its—its needs on surveillance, et cetera, et cetera, which forced the situation in 1978, but that's history. You gentlemen, at least Mr. Fuqua, knows probably better than I.

Mr. ANDREWS. Thank you, Mr. Chairman.

Mr. VOLKMER. The gentleman from Florida, Mr. MacKay. We still have about 5 minutes before we have to go vote if you want to ask some questions.

Mr. MACKAY. Dr. Kraft, I was very interested in Mr. Fuqua's question. The last meeting we had in this series, we were discussing whether it would be helpful and raise the visibility of these policy or goal kinds of questions, big-picture kinds of questions, if there was a statutory advisory group, and the issue we were attempting to discuss at the last meeting was whether the advisory groups that now function are under any constraints at all which would prevent them from being really open and candid with the Congress.

What is your opinion on that whole question of whether a high-visibility statutory advisory group that would have a responsibility not just to come here when we ask them, but would have a responsibility to report on its own initiative to the Congress?

Mr. KRAFT. Sir, as a Government servant for 38 years, when you start talking about advisory groups, I get shaking in my boots—and I'm wearing them today. [Laughter.]

I don't have—I have no—I have no objections to a high-powered advisory group if those people were advisers to NASA, which they already have. Be careful about creating another advisory group. I'm for destroying all advisory groups if you're going to create another one. If you're going to create a new advisory group, then for goodness sake, destroy the ones you've got.

Mr. **MacKay**. I share that view. That's all right, but one of the things you were saying, it seemed to me, to Mr. Fuqua was that there are times when NASA knows better but has constraints and can't say what it really knows.

Mr. **Kraft**. Yes, sir.

Mr. **MacKay**. Now, if we are the board of directors and there's no mechanism whereby the management can really candidly discuss policy issues with the board of directors, then you've got a serious problem. I don't care what you call it. You can call it a statutory advisory group; you can call it an internal auditor that reports directly to the Board. That is what would happen in a private-sector analogy.

Seems to me there's a major problem.

Mr. **Kraft**. I don't agree with that, sir. I happen to perform on an advisory—on a board of directors of a company in Houston for the last 7 years and I can't imagine that the board of directors would not be able to hear from the management of the company.

I think there are ways of doing that and I think that if you give the NASA Administrator the direction to formulate a plan and update that plan on a yearly basis, as you would as a member of that board of directors, I think he would have to come up with it, and I think it would be a good plan.

I think then that if you had an advisory group to the Congress to—to oversee the development of that plan and then possibly report to you on the validity of the process that took place, that would be the right thing to do, but I wouldn't want to second-guess NASA. I think that it ought to be left to NASA to do.

Mr. **MacKay**. I agree with that.

Thank you, that was a fine statement.

Mr. **Volkmer**. Anyone else have any questions before we recess?

If not, thank you very much, Dr. Kraft. We'll now recess for this vote and return at 11:30, at which time we will proceed to our next witness, Mr. Jerome Simonoff.

[Recess.]

Mr. **Volkmer**. The committee will come to order and we'll proceed a little out of turn as I understand Dr. Harr has a plane to catch so we'll proceed with our hearing with Dr. Karl G. Harr, president of the Aerospace Industries Association.

Mr. Harr, your statement will be made a part of the record in full and you may either review the statement in full, however you desire, or summarize.

STATEMENT OF KARL G. HARR, JR., PRESIDENT, AEROSPACE INDUSTRIES ASSOCIATION

Mr. **Harr**. Well, thank you, Mr. Chairman. It's not very long, perhaps I could read it as rapidly as I could summarize.

Mr. **Volkmer**. Fine.

Mr. **Harr**. I'd like to thank Mr. Simonoff and you, Mr. Chairman, for allowing me to move the order to accommodate my flight.

I'm Karl G. Harr, Jr., president of the Aerospace Industries Association of America, the trade association representing the Nation's major manufacturers of commercial, military and business aircraft, helicopters, aircraft engines, missiles, spacecraft and related components and equipment.

We appreciate the subcommittee's invitation to appear today to offer our thoughts on NASA's future mission and whether the basic policies of the 1958 National Aeronautics and Space Act are adequate to accommodate the changes that may lie ahead.

To achieve a clear perspective about our future national space effort, perhaps it's best to begin by facing up to some hard historical facts about the action-packed first quarter century in space. We must recognize that the United States did not decide to embark on a national space program as a consequence of a careful and orderly planning and policymaking process. Quite the reverse. We were virtually dragged into space kicking and screaming by Soviet initiatives and successes in that new arena.

In the interest of historical accuracy, I should point out that the Eisenhower administration officially launched a satellite program more than 2 years before Sputnik as the U.S. contribution to the international geophysical year. That plan, however, was not a reflection of serious American interest in the space potential. It was simply a diplomatic accommodation to the international scientific community.

The attitude of the day on the part of the administration, the Congress and the public was such that the original IGY satellite might well have been the entire U.S. space program for years to come had it not been for Sputnik.

It's important to recognize that prior to Sputnik, the United States was not ready to commit itself to anything resembling the national effort eventually undertaken.

However, Sputnik, and a rapid succession of other Soviet forays into space shook this Nation to the core. The American people were stunned and outraged. Our longstanding assumption of American technological supremacy was upended by the fact that another nation, and the Soviet Union at that, had raced ahead of the United States and become first in this new environment.

It was a serious blow to our national pride and prestige, but there was much more at stake in those early cold war days. The wholly unexpected Soviet technological demonstration presented the spectre of a badly underestimated Soviet military capability, shaking not only our own national confidence, but free world confidence in the United States.

There was a great surge of public demand for an immediate American response. Thus, the National Aeronautics and Space Act was passed. NASA was born and the Eisenhower administration was faced with the task through the newly created National Aeronautics and Space Council of deciding the nature and scope of our national counterthrust to the Soviet challenge.

At the beginning, nobody really knew how large to cut the cloth and there was little precedent to guide us. The scientific community suggested a wide range of concepts, most of them scientifically useful, but with minimal political benefit. Others clamored for a demonstration of far greater magnitude and visibility to display our national technological capacity and our determination to remain No. 1. The latter of you, of course, prevailed.

For a period of perhaps 12 years, roughly half of the space age, the U.S. space program enjoyed a national constituency crossing all political and regional boundaries, a constituency that generated full public support for the greatest organized technological thrust ever undertaken by a man.

The attitude of the American people was something like Super Bowl fervor on a grander scale. We were competing with our archrival and the excitement of the challenge was heightened by the enormity of the goal: putting men on the Moon.

So we sent a score of men to the moon and put 12 of them on the Lunar surface, an achievement that gripped the world's imagination as perhaps no other human accomplishment had ever done before. It handsomely served its purpose of restoring the luster to our tarnished image.

But then where were we? Even before the last man walked the Moon, public interest in space declined noticeably. This was understandable. There was the inevitable let down that follows in the wake of great accomplishment and although the competition with the Soviet Union continued, it had lost its urgency because of our own successes.

Flagging public interest was reflected in reduced NASA budgets in the 1970's, as NASA more or less limped into the shuttle era. I don't mean to imply that NASA and its industrial partners had lost their competence; far from it. We had the competence, but we lacked the public mandate to use it fully.

The space program moved much more slowly and on a much narrower front than might have been expected, given the extraordinary technological base provided by Apollo.

I have indulged, Mr. Chairman, in this historical preface because I think there are some essential lessons to be learned from it as we turn attention—our attention to where we are going in space for the next 25 years.

First, we must recognize that there existed in the latter 1950's no national consensus to commit large resources to space research. Without Soviet prodding, we would not have embarked on any significant space program at that time.

Second, we must accept the fact that even during those first busy 12 years, there was no national consensus as to our long-range objectives, where we were going beyond Apollo.

Third, it is very unlikely that we will ever again have the degree of national support we had in the post-Sputnik days. So the question becomes this: How do we develop a national consensus for the next 25 years of our space effort that will attract the national constituency adequate to support it?

I suggest the following: We can bring about a new consensus in constituency if we never lose sight of the fact that space offers us a three-dimensional world, a world in which many things can be done that cannot be done from the face of the planet or in the lower atmosphere. We can look at ourselves, our sea and land masses, from an entirely new perspective. We can reach a much larger portion of the planet at one time for such purposes as communication, navigation, surveillance, weather, or resources observation.

We can exploit a totally new environment, microgravity, for many exciting and promising purposes. We can look outward as never before. From above the atmosphere, we can see seven times as far as ground telescopes, and I should inject here, and of course, we can pursue scientific space activities of an enormous magnitude.

We are on the threshold of being able to take full advantage of this new dimension if we accept the challenge. We will find this new constituency among those who, for whatever reason, grasp this potential.

As we begin the second quarter century, there seems to be a resurgence of American interest in space, sparked in large part by the success of the space shuttle and a renewal of manned space flight. But there is no national consensus; nor is there a cleanly—clearly delineated national space policy.

NASA, of course, has a plan, but as we've heard discussed in earlier testimony, in the absence of a firm national long-range commitment, that plan is hardly more than a wish list. If we as a nation need a prod, we have it. It is the fact that we are once again facing strong competition in space, not only from the Soviet Union, but also from our Western European allies and Japan.

As with Sputnik, our response must be a national policy commitment to a long-range program designed to meet the competitive challenge and to reaffirm American dedication to a continuing leadership in science and technology.

I believe such a program should consist of a balanced effort embracing continuing development of an advanced space operations capability and a strong space science program with a particular focus on expanded research in space applications, as this is the area where we can expect to meet with the strongest competition.

Within this framework, we will have to encourage greater private American investment in space ventures because history shows us there is no greater stimulus to progress than the commercial marketplace. Such a program would, I believe, expand the level of public support, a necessity to the accomplishment of any long-range plan.

There is, as there has been since the beginning, a solid space constituency among the scientific and academic communities. Stimulation of private investment in space would increase the interest and support of the business industrial community.

And I believe that the nature of the advanced space program, coupled with greater public recognition that we are facing a new international competitive threat to our economic future would engender broader interest and support from the American people in general.

Foreign competitors are already mounting a strong effort to capitalize on the practical commercial aspects of space operation. They're competing in launch vehicles, upper stage boosters, communication satellite technologies, remote sensing of Earth resources, and space processing of materials.

We in the aerospace industry, accustomed to very strong competition from abroad in commercial transport manufacture, are well aware of foreign nations' dedication to the pursuit of business opportunities. We can expect competition to intensify in certain promising avenues of space exploitation.

At a time when we seem to be on the verge of realizing real dividends from the national space investment, we cannot afford to let other nations reap the harvest of the technologies we pioneer.

We must, therefore, make an additional investment in advancing those technologies that afford the most practical Earth benefits because they will be of the greatest economic interest and hence the focus of rigorous competition.

NASA should continue to develop satellite communications technology to enhance the attractiveness of U.S. satellites and equipment in the international market. This area of space commerce promises to reach exceptional levels in terms of economic value in the remaining years of this century.

Remote sensing of Earth resources seems to be a technology of vast potential benefit to users and providers of equipment alike, although it hasn't really taken hold yet. Both France and Japan have targeted this area as a special commercial opportunity.

To meet this challenge, NASA should continue to develop technology for space-based land resources survey and it should accord high priority to its work toward the related remote-sensing ocean observation systems.

Of all the identified areas of space applications, one of the most promising is materials precessing, or manufacturing in space, taking advantage of the microgravity environment to produce items that cannot be made on Earth. Evidence is mounting that orbital space offers a real opportunity for production of a wide range of superior Earth products.

The jury, let it be said, is still out on the economics involved. Space manufacturing entails working in an alien environment, where development costs are substantially higher than on Earth, to explore unproved processes in the hope of developing new product lines for which there is little solid market information.

I feel intuitively that this could become the broadest, most economically beneficial area of space applications, but as an industry representative, I'm well aware of the barriers to industry's participation: Risk, cost, and uncertain payoff.

To verify that a product opportunity actually exists demands extensive experimentation on the ground and in space. That requires heavy funding, considerably greater than that needed in normal industrial R&D, and it requires outlays well before commercial feasibility has been established.

The combination of high risk, large outlays and distant payoff, or the possibility of no payoff, may discourage many companies since every industrial investment must be weighed against all other opportunities that exist at the same time.

So if we expect to see broader U.S. industry participation in materials processing research, it is essential that the Government give priority to programs designed to reduce industry's risk. NASA's joint endeavor program, which reduces the front-end money needed for space experimentation, is an important step in the right direction. There must be additional steps.

Specifically, NASA should lead the way into this new field of industrialization through an expanded R&D program of orbital materials processing, a comprehensive program that would reduce industry's risk by accomplishing much of the enabling research, and so provide industry with the confidence to proceed with product developments.

In short, there is need for a materials processing counterpart to NASA's highly successful, absolutely vital trailblazing work in aeronautical R&D. It is important that the Government provide such support because space manufacturing is another area where foreign competitors are taking dead aim.

If space manufacturing does, in fact, realize its potential, it will write a new chapter of industrial history and spark broad economic activity: New industries, new product lines, new jobs. This is a field in which we enjoy a considerable lead over our European/Japanese competitors. The goal should be not simply maintaining that lead, but increasing it.

While pursuing practical applications and space science opportunities, NASA should also be provided with the support essential to develop a significantly more advanced capability for the types of space operations we see on the horizon. It is no longer science fiction to talk about manned lunar bases, mining asteroids, or manned expeditions for other parts of the solar system. Admittedly, missions such as those, and many others we can't yet imagine, are for the 21st century. But we must build toward them now.

Although the space shuttle represents an asset of great importance in our conquest of space, we must recognize that it is only a first step. It is still in an adolescent stage of development and even fully developed, it does not by itself represent a standalone capability for routine, repetitive, efficient, and economical operations in both low Earth orbit and high orbit.

I believe that maintenance of U.S. leadership in space requires that we continue to develop advanced technology toward what I might term a complete capability. Even given solid funding for this complete capability, it will probably take most or all of the next quarter century to achieve it.

By "complete capability," I mean that we should be able to operate in space on a continuous basis where today we operate on an intermittent basis. We should be able to operate routinely and repetitively in geosynchronous orbit as well as in low Earth orbit where today's shuttle operations are limited to altitudes below 500 miles.

We should be able not only to deliver payloads but to retrieve, service, and repair them in both low and high orbit; to deploy, assemble or construct large structures in orbit; to achieve efficiencies and economies by aggregating a number of payloads on large shuttle service multifunction platforms in either low or high orbit; and to direct and monitor all these space operations from a central hub, a manned space station.

I'm not proposing anything radically new. I'm urging that we commit to a long-range plan that embraces these and other capabilities that have long been contemplated as complementary systems for the shuttle. In other words, let's make a firm commitment to finish what we started.

The key element in advanced space operations is, of course, the permanent manned space station in low Earth orbit. Such a station would permit continuous space operations. It would provide a base for human-directed experiments in space science and applications.

It would provide a departure point for flight to geosynchronous orbit, to the planets, asteroids, and comets.

It would serve as a base for assembly, deployment and servicing individual satellites or multipayload orbiting platforms. It would be a center for space construction work, and most importantly, it would house facilities for space manufacturing and for advanced research in orbiter materials processing.

There will be a concurrent requirement for a number of new vehicles of the space transportation system. For example, teleoperator systems for a variety of orbital tasks, a new cargo vehicle for delivering large heavy payloads to low Earth orbit in the era of the space station, and reusable space-based orbital transfer vehicles to provide the connecting link between low Earth orbit and geosynchronous orbit.

That's an important part of the advanced space capability because most satellites now operate in geosynchronous orbit and eventually large multifunction unmanned platforms will operate there, but the geosynchronous orbit is well beyond the shuttle's reach.

Since the complete space capability will require servicing of such satellites and platforms, the orbiting transfer vehicle should eventually become a manned vehicle, shuttling between the space station in low Earth orbit and unmanned systems in geosynchronous orbit.

One other step will probably become necessary: A habitable facility at least periodically manned in geosynchronous orbit. Such a program seems technically feasible over the next quarter century. It need not involve an Apollo-like crash program, nor does it demand technological breakthroughs of Apollo dimension. It would significantly expand our national technological base, assure our continued leadership in science and technology, and position us to meet the anticipated space challenge from abroad.

Finally, it would generate and coalesce the kind of national space constituency necessary to sustain the program for the long term.

To conclude, AIA does not believe that amendments to the National Aeronautics and Space Act of 1958 are in order. NASA's broad objectives, as expressed by its charter, are as valid today as they were 25 years ago. What we need is renewed national dedication to those objectives, recognition of the opportunities for public benefit that space affords, and the national will to pursue those objectives.

Very quickly, that's my statement.

[The prepared statement of Mr. Harr follows:]

TESTIMONY OF
AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
CONCERNING
THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958
BEFORE THE
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U. S. HOUSE OF REPRESENTATIVES

October 25, 1983

Mr. Chairman and Members of the Subcommittee:

I am Karl G. Harr, Jr., president of the Aerospace Industries Association of America, Inc. (AIA), the trade association representing the nation's major manufacturers of commercial, military and business aircraft, helicopters, aircraft engines, missiles, spacecraft and related components and equipment. AIA appreciates the Subcommittee's invitation to appear here today to offer our thoughts on NASA's future mission, and whether the basic policies of the 1958 National Aeronautics and Space Act are adequate to accommodate the changes that may lie ahead.

To achieve a clear perspective about our future national space effort, perhaps it is best to begin by facing up to some hard historical facts about the action-packed first quarter century in space.

We must recognize that the United States did not decide to embark on a national space program as a consequence of a careful and orderly planning and policy-making process. Quite the reverse. We were virtually dragged into space, kicking and screaming, by Soviet initiatives and successes in that new arena. In the interest of historical accuracy, I should point out that the Eisenhower Administration officially launched a satellite program more than two years before Sputnik, as the U. S. contribution to the International Geophysical Year. That plan, however, was not a reflection of serious American interest in the space potential; it was simply a diplomatic accommodation to the international scientific community. The attitude of the day -- on the part of the Administration, the Congress and the public -- was such that the original IGY satellite might well have been the entire U. S. space program for years to come -- had it not been for Sputnik. It is important to recognize that, prior to Sputnik, the United States was not ready to commit itself to anything resembling the national effort eventually undertaken.

However, Sputnik and a rapid succession of other Soviet forays into space shook this nation to the core. The American people were stunned and outraged. Our longstanding assumption of American technological supremacy was upended by the fact that another nation -- and the Soviet Union, at that -- had raced ahead of the U. S. and become first in this new environment. It was a serious blow to our national pride and prestige, but there was much more at stake in those early Cold War days: the wholly unexpected Soviet technological demonstration presented the spectre of a badly underestimated Soviet military capability, shaking not only our own national confidence but free world confidence in the U. S.

There was a great surge of public demand for an immediate American response. Thus, the National Aeronautics and Space Act was passed, NASA was born, and the Eisenhower Administration was faced with the task -- through the newly created National Aeronautics and Space Council -- of deciding the nature and scope of our national counterthrust to the Soviet challenge. At the beginning, nobody really knew how large to cut the cloth, and there was little precedent to guide us. The scientific community suggested a wide range of concepts, most of them scientifically useful but with minimal political benefit. Others clamored for a demonstration of far greater magnitude and visibility to display our national technological capacity and our determination to remain Number One.

The latter view prevailed. For a period of perhaps 12 years, roughly half of the "Space Age," the U. S. space program enjoyed a national constituency crossing all political and regional boundaries, a constituency that generated full public support for the greatest organized technological thrust ever undertaken by man. The attitude of the American people was something like Super Bowl fervor on a grander scale; we were competing with an arch rival, and the excitement of the challenge was heightened by the enormity of the goal: putting men on the moon. So we sent a score of men to the moon and put 12 of them on the lunar surface, an achievement that gripped the world's imagination as perhaps no other human accomplishment had ever done before. It handsomely served its purpose of restoring the lustre to our tarnished image.

But then where were we?

Even before the last man walked the moon, public interest in space declined noticeably. This was understandable -- there was the inevitable letdown that follows in the wake of great accomplishment, and although the competition with the Soviet Union continued, it had lost its urgency because of our own successes. Flagging public interest was reflected in reduced NASA budgets in the 1970s as NASA more or less limped into the Shuttle era. I don't mean to imply that NASA and its industrial partners had lost their competence; far from it. We had the competence but we lacked a public mandate to use it fully. The space program moved much more slowly and on a much narrower front than might have been expected, given the extraordinary technological base provided by Apollo.

I have indulged in this historical preface because I think there are some essential lessons to be learned from it as we turn our attention to where we are going in space for the next 25 years.

First, we must recognize that there existed in the latter 1950s no national consensus to commit large resources to space research; without Soviet prodding we would not have embarked on any significant space program at that time.

Second, we must accept the fact that even during those first busy 12 years there was no national consensus as to our long-range objectives -- where we were going beyond Apollo.

Third, it is very unlikely that we will ever again have the degree of national support we had in the post-Sputnik days.

So the question becomes this: how do we develop a national consensus for the next 25 years of our space effort that will attract a national constituency adequate to support it? I suggest the following:

We can bring about a new consensus and constituency if we never lose sight of the fact that space offers us a three-dimensional world. A world in which many things can be done that cannot be done from the face of the planet or in the lower atmosphere. We can look at ourselves -- our sea and land masses -- from an entirely new perspective; we can reach a much larger portion of the planet at one time, for such purposes as communication, navigation, surveillance, weather or resources observation; we can exploit a totally new environment, microgravity, for many exciting and promising purposes; we can look "outward" as never before -- from above the atmosphere, we can "see" seven times as far as ground telescopes.

We are on the threshold of being able to take full advantage of this new dimension -- if we accept the challenge. We will find this new constituency among those who, for whatever reason, grasp this potential.

As we begin the second quarter-century, there seems to be a resurgence of American interest in space, sparked in large part by the success of the Space Shuttle and a renewal of manned space flight. But there is no national consensus. Nor is there a clearly delineated national space policy. NASA, of course, has a plan, but in the absence of a firm, national long-range commitment that plan is hardly more than a wish list.

If we as a nation need a prod, we have it. It is the fact that we are once again facing strong competition in space -- not only from the Soviet Union, but also from our western European allies and Japan. As with Sputnik, our response must be a national policy commitment to a long-range program designed to meet the competitive challenge and to reaffirm American dedication to continuing leadership in science and technology. I believe such a program should consist of a balanced effort embracing continuing development of an advanced space operations capability and a strong space science program -- with a particular focus on expanded research in space applications, as this is the area where we can expect to meet with the strongest competition. Within this framework, we will have to encourage greater private American investment in space ventures, because history shows us that there is no greater stimulus to progress than the commercial marketplace.

Such a program would, I believe, expand the level of public support, a necessity to the accomplishment of any long-range plan. There is, as there has been since the beginning, a solid space constituency among the scientific and academic communities. Stimulation of private investment in space would increase the interest and support of the business/industrial community. And I believe that the nature of the advanced space program, coupled with greater public recognition that we are facing a new international competitive threat to our economic future, would engender broader interest and support from the American people in general.

Foreign competitors are already mounting a strong effort to capitalize on the practical, commercial aspects of space operations. They are competing in launch vehicles, upper stage boosters, communications satellite technologies, remote sensing of Earth resources and space processing of materials. We in the aerospace industry, accustomed to very strong competition from abroad in commercial transport manufacture, are well aware of foreign nations' dedication to the pursuit of business opportunities -- and we can expect competition to intensify in certain promising avenues of space exploitation. At a time when we seem to be on the verge of realizing real dividends from the national space investment, we cannot afford to let other nations reap the harvest of the technologies we pioneered.

We must, therefore, make an additional investment in advancing those technologies that afford the most practical Earth benefits, because they will be of the greatest economic interest, and hence the focus of rigorous competition.

NASA should continue to develop satellite communications technology to enhance the attractiveness of U. S. satellites and equipment in the international market. This area of space commerce promises to reach exceptional levels -- in terms of economic value -- in the remaining years of this century.

Remote sensing of Earth resources seems to be a technology of vast potential benefit -- to users and providers of equipment alike -- although it hasn't really taken hold yet. Both France and Japan have targeted this area as a special commercial opportunity. To meet this challenge, NASA should continue to develop technology for space-based land resources survey, and it should accord high priority to its work toward the related remote sensing ocean observation system.

Of all the identified areas of space applications, one of the most promising is materials processing, or manufacturing in space -- taking advantage of the microgravity environment to produce items that cannot be made on Earth. Evidence is mounting that orbital space offers a real opportunity for production of a wide range of superior Earth products. The jury, let it be said, is still out on the economics involved. Space manufacturing entails working in an alien environment, where development costs are substantially higher than on Earth, to explore unproved processes in the hope of developing new product lines for which there is little solid market information. I feel intuitively that this could become the broadest, most economically beneficial area of space applications, but as an industry representative I am well aware of the barriers to industry's participation -- risk, cost and uncertain payoff.

To verify that a product opportunity actually exists demands extensive experimentation on the ground and in space. That requires heavy funding, considerably greater than that needed in normal industrial R&D -- and it requires outlays well before commercial feasibility has been established. The combination of high risk, large outlays and distant payoff -- or the possibility of no payoff -- may discourage many companies, since every industrial investment must be weighed against all other opportunities that exist at the same time.

So, if we expect to see broader U. S. industry participation in materials processing research, it is essential that the government give priority to programs designed to reduce industry's risk. NASA's Joint Endeavor Program, which reduces the front-end money needed for space experimentation, is an important step in the right direction. There must be additional steps.

Specifically, NASA should lead the way in this new field of industrialization through an expanded R&D program of orbital materials processing, a comprehensive program that would reduce industry's risk by accomplishing much of the enabling research, and so provide industry with the confidence to proceed with product developments. In short, there is need for a materials processing counterpart to NASA's highly successful, absolutely vital trailblazing work in aeronautical R&D.

It is important that the government provide such support because space manufacturing is another area where foreign competitors are taking dead aim. If space manufacturing does in fact realize its potential, it will write a new chapter of industrial history and spark broad economic activity -- new industries, new product lines, new jobs. This is a field in which we enjoy a considerable lead over our European/Japanese competitors; the goal should be not simply maintaining that lead, but increasing it.

While pursuing practical applications and space science opportunities, NASA should also be provided with the support essential to develop a significantly more advanced capability for the types of space operations we see on the horizon. It's no longer science fiction to talk about manned lunar bases, mining asteroids or manned expeditions to other parts of the solar system. Admittedly, missions such as those, and many others we can't yet imagine, are for the 21st century. But we must build toward them now.

Although the Space Shuttle represents an asset of great importance in our conquest of space, we must recognize that it is only a first step; it is still in an adolescent stage of development and, even fully developed, it does not by itself represent a standalone capability for routine, repetitive, efficient and economical operations in both low Earth orbit and high orbit.

I believe that maintenance of U. S. leadership in space requires that we continue to develop advanced technology toward what I might term a complete capability. Even given solid funding for this complete capability, it will probably take most or all of the next quarter-century to achieve it. By complete capability I mean that:

o We should be able to operate in space on a continuous basis, where today we operate on an intermittent basis.

o We should be able to operate routinely and repetitively in geosynchronous orbit as well as in low Earth orbit, where today Shuttle operations are limited to altitudes below 500 miles.

o We should be able not only to deliver payloads, but to retrieve, service and repair them in both low and high orbit; to deploy, assemble or construct large structures in orbit; to achieve efficiencies and economies by aggregating a number of payloads on large, Shuttle-serviced multifunction platforms in either low or high orbit; and to direct and monitor all these space operations from a central hub -- a manned space station.

I am not proposing anything radically new. I am urging that we commit to a long-range plan that embraces these and other capabilities that have long been contemplated as complementary systems to the Shuttle. In other words, let's make a firm commitment to finish what we started.

The key element in advanced space operations is, of course, the permanent manned space station in low Earth orbit. Such a station would permit continuous space operations; it would provide a base for human-directed experiments in space science and applications; it would provide a departure point for flight to geosynchronous orbit, to the planets, asteroids and comets; it would serve as a base for assembly, deployment and servicing individual satellites or multipayload orbiting platforms; it would be a center for space construction work; and, most importantly, it would house facilities for space manufacturing and for advanced research in orbital materials processing.

There will be a concurrent requirement for a number of new vehicles of the Space Transportation System -- for example, teleoperator systems for a variety of orbital tasks; a new cargo vehicle for delivering large, heavy payloads to low Earth orbit in the era of the space station; and reusable, space-based Orbital Transfer Vehicles to provide the connecting link between low Earth orbit and geosynchronous orbit. That's an important part of the advanced space capability because most satellites now operate in geosynchronous orbit, and eventually large multifunction unmanned platforms will operate there, but the geosynchronous orbit is well beyond the Shuttle's reach. Since a complete space capability will require servicing of such satellites and platforms, the Orbiting Transfer Vehicle should eventually become a manned vehicle shuttling between the space station in low Earth orbit and unmanned systems in geosynchronous orbit. One other step will probably become necessary: a habitable facility, at least periodically manned, in geosynchronous orbit.

Such a program seems technically feasible over the next quarter-century. It need not involve an Apollo-like crash program, nor does it demand technological breakthroughs of Apollo dimension. It would significantly expand our national technological base, assure our continued leadership in science and technology, and position us to meet the anticipated space challenge from abroad. Finally, it would generate and coalesce the kind of national space constituency necessary to sustain the program for the long term.

To conclude, AIA does not believe that amendments to the National Aeronautics and Space Act of 1958 are in order. NASA's broad objectives as expressed by its charter are as valid today as they were 25 years ago. What we need is renewed national dedication to those objectives, recognition of the opportunities for public benefit that space affords, and the national will to pursue those opportunities.

Mr. **Volkmer**. Thank you very much, Mr. Harr.

I recognize the gentleman from Virginia for any questions he may have.

Mr. **Bateman**. Thank you very much, Mr. Chairman.

I enjoyed such portions of the testimony as I was able to hear, having to run out for other discussions. I appreciate the bottom-line conclusion that you don't feel that anything is broken so it doesn't need to be fixed, which is a view that I tend to share in terms of the need for legislation. I would necessarily want, Mr. Chairman, to reserve judgment on the order of priorities within the programs and projects that are recommended, but I think the statement of the witness is a very definite contribution to the work of the committee, and have no questions for the witness.

Mr. **Volkmer**. Thank you very much. I do have some questions.

During these hearings and before, there have been suggestions by some, including members of the committee, to include language in the Space Act to state basically that NASA, in a policy provision, NASA should promote more commercialization of space. You don't feel that that's necessary?

Mr. **Harr**. Mr. Chairman, it might be helpful in the areas of that part of our society, and I'm thinking now mostly the industrial part of our society that is not familiar with the existing efforts that have been made, but I don't think it's necessary or worth changing Acts.

Mr. **Volkmer**. OK. Now, early in your statement, you call for balanced program of advanced space operations capability and a strong space science program, with particular focus on expanded research and space applications.

Do you believe that NASA's present program is balanced?

Mr. **Harr**. Mr. Chairman, I do within the inevitable and permanent confines of a budget they're always going to have to deal with. Now, obviously, this is an issue that's under constant controversy. The space science people never feel that they're getting their share of the—of the budget, but I—I think there's an important point to be made there. We—we only have had a successful space science program because of the enabling technology that was produced to—to allow it to exist and I think that space science pursuits are—perhaps in the long term can be argued in the long term—the most important thing that we can do in space in terms of payback over the long term.

But they won't happen unless and until we get some of the hardware in order and so I think the space scientists ought to appreciate that and keep ramming for their place in the budget and the priorities they should have to recognize that without things like the Apollo program, which was not a science program, really, at all; it was a technological program, they wouldn't be anywhere.

I think of the little boy whose father buys him an electric train set, a nice, expensive electric train set for Christmas and the little boy's delighted until the father plays with it all the time, won't let him play with it. But he—he ought to realize whatever time he does get, he wouldn't get if it weren't—if his father hadn't bought the train set. [Laughter.]

Mr. **Volkmer**. To continue on, I'm just trying to get the gist of your emphasis. I realize that basically you're trying to outline a program where we get more involvement in space, space stations, geosynchronous orbit, et cetera, but when I review that, it appears to me that you're focusing on more what I call in the future, more application, expenditures which would be on operations and not necessarily on space science or planetary exploration or that type of thing.

Mr. **Harr**. That is correct.

Mr. **Volkmer**. Do you——

Mr. **Harr**. The reason——

Mr. **Volkmer**. Yes, go ahead.

Mr. **Harr**. Well, the thrust, underlying thrust of our statement here is that if we look back at the history of how we got into space and how we decided what we would do when we got into space and where we stand now and look ahead in terms of our objectives, it was all pretty accidental and externally stimulated. It produced an enormous consensus. We were scared as a people, but the consensus, while it was nationwide in breadth, was only as shallow as that and was completely or largely vitiated by the achievement of our own space success, particularly the Apollo program, and within the realities of what the national consensus is to support, for instance, highly expensive space science programs and the technology that would be required for them, I am suggesting that that will not happen unless we develop and sustain a national constituency. It will never approach what we had after Sputnik, but at least a solid national constituency that recognizes that space is good for us and the way, I suggest, that is going to happen is when the profit nerve or the entrepreneurial nerve of the great American business machine or industrial machine—economic machine's a better way to put it—is effectively tapped and the way to get there is to produce improved opportunities for industrial investment and these include the items that I've suggested without any priority or without any suggestion of any specific ones being needed to be done.

But until we get capabilities—and this is where I think NASA's primary role should be in the next 25 years—until we get improved national capabilities for doing the things that we propose to do in space, they probably won't be able to tàp that private investor nerve adequately to support a national consensus.

Mr. **Volkmer**. In other words, we—what I hear from you is we have to have the other things in order to get the national consensus to spend the money on the planetary and on the space sciences.

Mr. **Harr**. Yes. I don't think it'll happen without that. They're expensive. I'm afraid—I regret it terribly, but I'm afraid there's not that kind of a national political consensus.

Mr. Chairman, if I may just diverge for a minute, I was in on the beginning of this space operation in a very central spot in the White House and when Sputnik happened, and when the American people reacted and Congress passed law, it set up not only NASA, but it set up the National Aeronautics and Space Council. We didn't have much to build on. We had scientists from NACA; we had image people like myself who were concerned about what it was doing to the country's political status abroad and so forth. We didn't have engineers; we didn't have administrators; we didn't have anybody with any experience commensurate to the challenge.

We didn't even know how large a bite to take because we didn't know how much we could do intelligently and it was somewhat miraculous that under the—under the prodding of the several programs we started—but principally, obviously, the Apollo program in the end, there was created absolutely superb managerial systems organizing capability within the Government, within NASA, and there evolved an extremely unprecedented and perhaps unfollowed industrial governmental relationship to pull off this—this—this feat.

But we started from no clear picture as to what we wanted to do except to reassure the American people and the world that we were not being overtaken by anybody. Now we have, of course, developed over these 25 years great knowledge in—in Government and in industry and in academia, as to the elements that are required to get into—support a reliable space program somewhat deteriorated through the neglect of the seventies, but still very strong and very much in place and the job seems to be to pull all that together and find some way to hitch the flywheel to the driveshaft in terms of unleashing the energy and creativeness of the private economy in space-related activities.

That's happening, of course, as we're all aware, as you're very well aware, an awful lot of that's going on and an awful lot more of that is planned for, but we still haven't made the big linkage. We still haven't got the engine of American free enterprise economy solidly behind the space effort.

I'm not talking about our industry, because we're in it. We've been in it from the beginning. We make the stuff. We sell an account. I'm talking about the other—rest of the economy.

Mr. **Volkmer**. Along those lines, and—because you emphasize it, and I think everyone recognizes the possibility to get industry into more materials processing. Microgravity processing in space is a very promising area, and yet you state that you're aware of the barriers to industry's participation, risk, costs, uncertain payoff.

How do we—or NASA—address those problems? Is it through more research, basic research in that area? How do——

Mr. **Harr**. I think NASA's priorities should include programs that increase—well, even including the research on the processing of materials, both here and in space, yes, I think that that has to be brought closer to something affordable by industry.

Let me give you an example, Mr. Chairman, which I'm sure you're very familiar with. Ongoing, and for years ongoing, has been NASA's enormous contribution to our aviation advances and without them, we would be nowhere near where we are today. Let me say quite strongly. And we hope they will continue.

We think that the aeronautical R&D portion of NASA's efforts, which is budgetwise a small, relatively small portion, one of the most important things they do. But in that, there's a constant controversy between industry and the Government and it's argued in Congress and so forth from time to time about at what stage an industry pick up the load and industry is always saying, "Well, this stage," and NASA saying, or someone in Congress is saying a little earlier than that.

But nevertheless, it has worked and it has worked for a lot of reasons that don't necessarily apply completely to space, one of which is that the proof—the market is proven if you get a better airplane, you're going to sell it to people who are flying.

We still don't know if you get a better materials process that there's that much market for it or whatever.

Mr. **Volkmer**. The last question I have you have described again in your statement is how NASA might achieve complete capability over the next 25 years in the program and you say it's technically feasible. My question to you is, as a member up here who looks at budgets and sees what OMB does, Do you believe it's financially feasible within the Government to do it——

Mr. **Harr**. Well, I think that's——

Mr. **Volkmer** [continuing]. With the strength that we have?

Mr. **Harr** [continuing]. That's the key question. I mean, I think that what we're all trying to do is relatively simple. It's the how that we're talking about, and I guess what I've tried to suggest with this statement and my other remarks that unless there is some kind of a public consensus which will be reflected in the Congress of the United States that will support it, we're not going to get over a continuous period of years going solely on Federal funds, we're not going to get the financial support for it, even if it were high today, it wouldn't be tomorrow. It goes up and down with pressures of other priorities and so forth.

Therefore, I think that the real question is, how can we, in time, and intelligently harness the free enterprise industrial capacity and appetite? I mean, our guys have enormous appetites. You give us something to go for that we think we can get, we'll go for it, but within the confines of a prudent business decision.

I think—no, it's not financially feasible if it's left to the government alone; yes, it is financially feasible if we can commercialize it.

Mr. **Volkmer**. Thank you very much, Mr. Harr. I have no further questions.

The gentleman from Virginia have any questions?

[No response.]

Mr. **Volkmer**. Thank you very much, and you've been very informative and very helpful in our deliberations.

Mr. **Harr**. Thank you.

Mr. **Volkmer**. Our final witness today is Mr. Jerome Simonoff, vice president, Citicorp Industrial Credit, Inc.

Mr. Simonoff, your statement, too, will be fully made a part of the record. You may either summarize the statement or review it in full, however you so desire.

STATEMENT OF JEROME SIMONOFF, VICE PRESIDENT, CITICORP INDUSTRIAL CREDIT, INC.

Mr. **Simonoff**. Thank you, Mr. Chairman. Let me thank you for your invitation. This is a high point in my professional career, just being invited here.

I'll summarize the statement. I want to also amplify on a couple of points and let the statement, as I've submitted, stay in the record.

Mr. **Volkmer**. Fine.

Mr. **Simonoff**. As I said in my statement, these opinions are my own and they're not necessarily those of my employer.

What I want to do is to discuss the financing issues of satellites in general and how NASA can participate in this; the foreign competition issues we face, some of which are directly germane to NASA and some which are not, but NASA certainly should be dealing with other parts of the Government on these matters; and how NASA can help entrepreneurs develop business in space. And, I want to make various recommendations.

As I've said in my statement, my fundamental underlying position is that the space programs should be designed and operated for transfer to the private sector whenever possible. However, the costs of these activities are so great that it should be recognized that NASA is going to have to maintain virtually a continuous involvement in many of these programs.

In the issues of financing today's systems, the underlying issue is the high cost. The high cost itself of a system does not limit investors in space activities to governments and well-capitalized institutions. However, it does limit the types of activities that can be undertaken due to the limited-risk appetites of professional or institutional financial organizations.

For example, a commercial project, to get investment, must compete for funds in the capital markets against totally unrelated entities and on a relatively uniform basis. The index, or the measure of competition for these funds is the return on investment and if you take a look, for example, at a brandnew de novo communication satellite system today, you're talking about a $300 million investment. This would consist of two satellites in orbit and one spare on the ground.

Now, if you assumed—to give you an idea of the order of magnitude of these numbers—if you went for a 20-percent return on investment, that says that you would have to earn $60 million a year. Now, on a well-managed company to generate $60 million a year, you would have to generate $600 million a year of revenue, of sales, and for a startup company, this is totally unrealistic to get from here to there and achieve the target rates of return.

So this says the investor in any venture is then left with two choices: He can shrink the size of the system, perhaps launch a minicommunications satellite, which would be totally inefficient; or he can reduce the size of the investment in the same size of system, and the way you do that is to borrow money to do this.

Now, once you borrowed money, you've shrunk the size of the investment; you have smaller revenue; this means you need smaller earnings, and this is what utilities do in order to keep their telephone rates or power rates down, is to substitute debt for investment, for equity.

Now, when you introduce the debt into the systems, you substitute a class of very, very conservative suppliers of funds. The risk tolerances of these lenders are so low that they actually constrain the system design. Now, if we look back historically in the TDRSS example where the original concept was to have commercial ventures take risk for a leading-edge technological development, the commercial ventures had to borrow money to reach their rates of return that the companies needed to be able to finance themselves.

The level of risk that was involved in technological development was incompatible with the acceptance of the commercial sources of debt. Consequently, you ended up with a Federal financing bank taking over the financing of the TDRSS system.

Today's capital markets have the capacity to finance the largest systems. I mean, there's no space system today that can't be financed commercially. As a matter of fact, I've seen as much as $6 billion raised on a corporate takeover and there's no commercial system of that size today.

However, the willingness of the market to supply the debt has been principally to supply this type of financing—which must be debt, because you're not going to raise that much equity—is based principally upon the predictability of the repayment of the debt, and in the case of space, it's been based upon the ability of the insurance market to grow, to support the losses from a possible launch failure or premature end of life.

Now, one of the problems I see coming, although we don't have it right now, but you could see this happening, is a limitation of the supply of funds due to the limitation of today's underwriting capacity and the reluctance of most underwriters to provide launch insurance for more than 1, and in some cases, 3 years in the future. And the reason for the 3-year limitation is that most insurance—most launch insurance today comes from Lloyd's of London, and they operate on the 3-year cycle.

I'm advised, of course, by underwriters and brokers that the reasonable limit for one launch is $150 to $200 million per launch. That is the key issue. You may get more insurance, but not concentrated on any more than one launch.

Now, if you look at the value of a fully loaded space shuttle, you just can't raise that much insurance. Fully loaded space shuttle—say, three Delta-class satellites—that's $50 million apiece, so it's $150 million a payload, delivered to the shuttle. Then you've got the shuttle costs on top of that. Maybe that's—with whatever boosters—maybe that's $30 million apiece, so that $150 plus $90 is $240 million, and you've got insurance on top of this, so you just can't get there. So what you end up with is, then, an underfinanced payload or inability to fully finance.

Another example where you could have a restriction is if I were to start a company to build a platform, say a leasecraft or an SPAS type of platform. The costs of building this thing are so great that I could not make this thing profitable with my own funds. I would have to go to the banks to substitute my investment with—to substitute debt for my investment.

The way I would then finance, I would then get a bunch of passengers and I would aggregate the contracts to ride. I would say, "OK, it's going to cost me $100 million to build the platform. I'm going to have to aggregate $100 million worth of rental contracts or transportation contracts and when I have that, I can go to my funding sources." I say, "Here is your assurance of repayment; give me my money."

What will happen, the space shuttle's launch schedule and the time to get these things launched, these contracts will have to take place over a long period of time. If those launches take place past the 3-year limit, then I don't have enforceable contracts I can lend money against as a banker.

Therefore, the aggregation has not taken place and, therefore, it's underfunded.

Now, as a solution to these two constraints, I'm suggesting that if the insurance underwriting market cannot develop adequate capacity, that NASA borrow an idea from the Federal Reserve System and become what I call an "insurer of last resort," as the Fed is the "lender of last resort."

NASA, subject to its acceptance of a particular contract, based on its own technical risk analysis, would offer launch and life insurance to cover shortfalls from the commercial markets at premium rates higher, and I stress "higher," than the highest quoted rate.

Now, the reason for this is that NASA would be there supplying insurance unless the insurance market grows, and as the market grows, then NASA would be replaced and then I would see no serious competition between the Government and the commercial role in supplying insurance.

In foreign competition, I feel there are four issues here that are involved with foreign competition. One is the availability of subsidized financing for exports, which is both a NASA operational and payload manufacturer issue; a supplementary launch financing issue which is strictly limited in this case to NASA supply launch services; a countertrade or offset capability and a cross-subsidization of products, which I'll discuss in further detail.

Subsidized financing involves the use of the Eximbank or cross-border leases to lower the effective interest costs for satellites. There's been a great deal of interest in the Ariane financing package and what can they do.

Most of NASA's subsidized financing comes principally from the Eximbank or subsidized source, although it may not necessarily be used, will come from the Eximbank's lending rates which are designed basically to match any subsidized financing a U.S. exporter faces—not necessarily beat one, but match it.

At present, NASA has received very good support from the Eximbank and the Eximbank's capabilities are adequate so long as other foreign agencies, such as COFACE and HERMES, which is the German—COFACE, the French; and HERMES, the German—and other groups follow the OECD-agreed-upon rates.

In today's rate environment, and given the OECD interest rates, the Eximbank's guarantees of borrowings at commercial rates are actually more attractive than the direct loans. In recent years, there's been a great deal of discussion about the COFACE, the French exotic financings supporting Ariane and in reality, it hasn't been exotic and what the French—what COFACE has done is simply followed OECD guidelines and provided subsidized rates that are standard for export financings of the nature that were there.

What causes such a great visibility in my opinion was that NASA did not match these and that the financing was credited for allowing Ariane to win a substantial number of launch contracts in the United States. In reality, if you looked at the numbers, Ariane did not beat the space shuttle. Ariane, in competition, really beat the Delta, which is a higher priced vehicle, and if you compare the—once the shuttle became available, the shuttle won many more competitions against Ariane, and if you look at today's pricing, that even with the export financing of Ariane, the shuttle was still more attractive—it was still cheaper.

Now, one issue. There have been occasions where there would be a separate launch financing needed by NASA. The reason I say they're mostly unneeded is because, it takes 3 years to build a satellite. We have to borrow funds or finance the construction of the satellite. No funding source will advance funds to build a satellite if there is not enough money to launch the vehicle, so usually the buyer will line up all financing prior to entering into contracts for transportation of payloads.

In a certain case—certain cases, however, NASA, as a vendor or any vendor will undertake certain customer financings to fill in the shortfalls that the Eximbank can provide, which is an OECD-agreed-upon activity. Now, so long as NASA is a commercial vendor, it should be allowed to finance out of its own funds or guarantee financing at its own risk those shortfalls. These tend to be very small. The shortfall under an Exim guarantee is 15 percent of the value of the export.

However, I recommend that it be limited to cases where the Eximbank or Agency for International Development is providing the major portion of the support and then there is coordination between the agencies because NASA is not in the money-lending business and should not develop an organization to do this.

One issue that is the key issue for subsidized financing that is an important one that I particularly feel strongly about is the cross-border tax lease. If you take, again, that same basic entry-level exported system—that $300 million system—two satellites and a ground spare, the tax lease, which is a vehicle for American ownership of satellites that are leased to foreign users but the foreign users have de facto rights of ownership from their operating standpoint will provide, in essence, a free ground spare or about $50 million reduction or 15 to 20 percent reduction in price.

Now this is important because the U.S. tax market is so large it gives the American exporter a very strong protection against foreign subsidized competition where there might be an infant industry type of protection from the smaller economy that the United States is competing with. It's like having an arrow in our quiver—in our competitive quiver.

Now, as currently proposed, the Pickle-Dole legislation, H.R. 3110, which basically makes the cross-border leasing uneconomical. Now the genesis of the removal from the export side was a very well-founded basis that Representative Pickle had. He had asked the question, "If you buy a Japanese satellite and lease it to a British user, why should the American taxpayer in essence subsidize a Japanese export?"

So in order to offset that question, which I think is perfectly justified on his part, that there should be a U.S.-content test in this thing, or say at least 50 percent of the value of the exported satellite should be U.S. content. To the extent that there's lost revenue to the Treasury, I would point out if the export never occurs, there's lost revenue because the workers aren't paying their income taxes. So I think it's a neutral issue as far as Treasury is concerned for the offset.

The last issue I have here is countertrade or offset. This is the requirement of a U.S. exporter to buy a foreign export from the country to whom he's selling a piece of equipment. When NASA competed against Ariane for selling the launch services to Australia, there was—there was an offset requirement question. In this particular case, it was a requirement to make technological investments in Australia.

Now, NASA developed an ad hoc method for doing this. I had done—I believe they went to its vendors. I'm not sure the precise details, but there was an ad hoc cure. But if you have a thinly capitalized small exporter who's going to be developing large or space systems for export, NASA is going to provide export for the shuttle services.

The offset capabilities simply are not present so I would recommend that NASA, in this case, work—develop a working relationship with the Department of Commerce or the Office of Special Trade Representative or, if ever it comes about, the Department of Trade, to develop an institutionalized mechanism for this type of support, this offset support.

Finally, I have something called cross-subsidization of products. This is a type of thing where if you are exporting a satellite, some of the direct broadcast satellites—internationally, direct broadcast satellite has, I think, a strong potential than in the—in the United States, the high-power ones. It's conceivable that the value of the ground equipment could be considerably greater than the value of the space segment and if the United States has an advanced technology space segment and a competitor has a much more primitive space segment, the primitive will be reflected in the fact it will cost more, but if that competitor also has ability to develop very low-cost ground production capability, then when you add the two together, the ground and the space together, the U.S. competitor will have a more economical export and the U.S. space exports can be blocked.

Now, it is not NASA's burden, I think, to build an export capability for ground equipment, but NASA can in certain cases undertake certain ventures in which they will create the environment for the ground equipment to develop. One is the 30/20 gigahertz program that NASA has already undertaken where 30/20 manufacturers say, "OK, we now have a space segment available. We will now—perhaps it's worth our while to make the investment at levels we can afford, since we can't afford the $200 or $300 million, whatever the space segment investment would involve."

Another might be the mobile satellite—a mobile cellular satellite system like the 800 megahertz program that NASA's currently looking at.

The last area here is the support for entrepreneurial activity. Now, as I mentioned earlier, the biggest barrier to entrepreneurs is the high cost of doing business in space. It's been reported that most early-stage ventures are under $15 million. I believe the numbers are considerably lower. When you have a startup company, it may be as low as a few hundred thousand dollars.

Now, to the extent that you need more funds, then you have to go for subsequent rounds of financing or you have to have sponsors or other cost sharing. Otherwise you end up with only the most strongly capitalized companies doing the venture work and I think that one of the most imaginative commitments, of course, is the electropheresis thing that McDonnell Douglas is doing, but for a small company to do this type of thing would be unrealistic.

Now, I believe that for the Government—the Government clearly if they're going to develop a capability in space and draw the entrepreneurs in, this cost has got to be reduced.

Now, if my preference is for the Government to provide an infrastructure—that is, reduce the costs of doing things in space—of activities in space—by activities in kind. I do not believe it is appropriate for the Government to make investments in companies. The problem with making investments in ventures is one day somebody is going to look at their measurement of how successful is the investment and they're going to go right back to the rate of return and if somebody managing a rate of return type of investment is measured on its performance, he's going to go after the best investments, which would be the same investments that the commercial markets will go after, and what will happen is no money will be available for infrastructure development such as the shuttle rides.

So the form of infrastructure I would recommend would be procurement of technology; that is, going to particular countries. If NASA feels there should be a microcircuit type of development, go to a company and say—and enter into a procurement contract where the company must learn the capability. This is done by the Air Force today. Low cost accessible transportation, space platforms, space station and low cost, easily available information on non-security-related developments.

Now, I question some of the—the beliefs—and this, again, is very personal, as to whether, if you follow this policy, you can ever get to where you can make, say, a space shuttle pay for itself. If I go into my program where I'm going to develop my $100 million platform and I don't have that much money, and I'm going to aggregate my commitments, my sources are going to say—my banks are going to say, "OK, Mr. Simonoff, you are going to have commitments to ride on the space shuttle." I have to have commitments for the space shuttle maybe 7 years out running.

Now, very few companies are going to be able to commit 7 or 8 years for space shuttle rides. Now, if the space shuttle tends to be full, and you're not building the fifth or the sixth orbiter, then what will happen will be if the supply of capacity is not there, then again, I can't be financed because there's no assurance of the revenue necessary to generate the funds, which means that you may find that you're going into a deliberate inefficiency in regard to the space shuttle or transportation of this type.

Now, the limits of subsidy that I feel are appropriate for—for Government commercialization, I limit to support in kind. I am reluctant to encourage exotic or special tax incentives that are not available to the rest of industry, not only—principally because I would be concerned about the creation of an industry distortion.

Some years ago, there was a great demand to invest in boxcars because of the tax shelter opportunities available in boxcars and tremendous investment pressure of boxcars and companies were building boxcars in record numbers. There was only one problem:

The demand—the ultimate final demand for boxcars didn't increase; there was no—the commensurate increase was not there.

The result was a great deal of people—a great number of people, rather, lost a great deal of money. Now, if you had the same type of incentives which might draw a tax-driven investment just for the sake of a near-term tax saving that was beyond what's available from normal conventional measures, and you have the same losses, then what happens after the dust settles and say, "Okay, now we need some investment"? Now you have investment-shy financial markets who won't provide funds. So this is why I would strictly limit NASA—or I would principally limit NASA to the payment-in-kind infrastructure type of maintenance.

In summary, I believe that NASA has most of the inplace capability right now to do all this. I feel that there are probably no major changes needed in the enabling legislation unless perhaps a clarification that NASA should be allowed to engage in certain operational activities so long as it encourages the development of the Nation's space infrastructure.

Thank you. That's all I have.

[The prepared statement of Mr. Simonoff follows:]

Statement by

Jerome Simonoff

Vice President - Citicorp Industrial Credit, Inc.

My name is Jerome Simonoff. I am a Vice President of Citicorp Industrial Credit, Inc. and of Citibank, N.A. I am involved in commercial financing of various commercial space projects. The views expressed in this testimony are strictly my own and do not necessarily reflect any authorized or official Citicorp views.

I wish to discuss financing issues of satellite systems in general, foreign competition, and how NASA can help entrepreneurs to develop business in space. I will make various recommendations for NASA to play a supporting role.

My fundamental, underlying position is that space programs should be designed and operated for transfer to the private sector whenever possible. However, the costs of these activities are so great, that it should be recognized that NASA's involvement will be necessary over long periods of time to facilitate these transfers.

Financing Today's Systems

The underlying issue involved in space system training is high cost. High cost by itself does not limit investors in space activities to governments and well capitalized companies; it does, however limit the type of activities that can be undertaken due to the limited risk appetites of professional or institutional financial organizations.

Commercial projects must compete for funds in the capital markets on the basis of comparative returns on investment. However, today's projects are so large that virtually unrealistically high revenues must be generated early in a project to reach competitive levels of returns. The investor is then given two choices to work with lower, realistically attainable revenues: (1) shrink the project to less than optimally efficient size, or (2) reduce the investment. The latter is done by replacing some investment with borrowed funds.

While the introduction of debt magnifies the system profitability, it also introduces a class of very conservative suppliers of funds. Lenders' risk tolerances in effect constrain the design of the system. Lenders will not necessarily look to the strength of capitalization of the investor; they will look to the assurance of revenue to repay the loan. This means the greater assurance of performance to enable repayment, (i.e., the less the operating performance of the investor-operator) the greater the proportion of borrowed funds available relative to investment. An example of a low added performance system is a communications satellite condominium where portions of capacity (called "transponders") are sold or leased. A high added value system would be a direct broadcast satellite. In this case revenue to the operator comes from public acceptance on an on-going basis of programming material. This latter system is extremely difficult to finance with large portions of debt.

Today's capital markets have the capacity to finance the largest systems. The willingness of the market to supply debt has been based principally upon the presence of insurance to protect against losses from launch failure and premature end of life. However, the supply of funds could be potentially restricted by today's limits of insurance underwriting capacity and the reluctance of most underwriters to provide launch insurance more than one (and in some cases three) years in the future. For example, I have been advised by underwriters and brokers that the reasonable limit on one launch is $150-200 million. This figure is less than the value of a three "Delta class" satellite payload on the Space Shuttle. The reluctance to enter into longer term future commitments does not seriously impede financing of today's communications satellites. However, applications involving multiple future launches, such as in-space manufacturing could have funding availability problems.

If the insurance underwriting market cannot develop adequate capacity, I suggest that NASA borrow an idea from the Federal Reserve System and become an "insurer of last resort." NASA, subject to its acceptance based on its own technical risk analysis, would offer launch and life insurance to cover shortfalls from the commercial markets of premium rates higher than the highest quoted rate. As additional commercial insurance coverage becomes available, NASA's coverage would be replaced by the user.

Foreign Competition

There are four major financial issues involving foreign competition: the availability of subsidized financing, supplementary launch financing, counter-trade or offsets, and cross-subsidization of products--a potential but not yet current issue.

Subsidized financing involves use of Eximbank loans and cross-border leases to lower the effective interest costs for satellites. Eximbank's lending rates are designed to essentially match subsidized rates of foreign export agencies. With regard to NASA, subsidized funding issues are of greatest relevance to the marketing of Space Shuttle launch services. At present, NASA receives satisfactory support from the Eximbank as long as other export agencies maintain OECD agreed-upon rates. In today's interest rate environment, the Eximbank's guarantees of borrowings at commercial rates are more important than direct loans. In the recent past, when rates were higher and Eximbank loans were more attractive, the Eximbank matched COFACE's (Compagnie Francaise d'Assurance pour le Commerce Enterieur) offers except for certain Ariane launch services sold to American users. In my opinion, this asymmetry did not materially help Ariane. Once the Shuttle became available on a predictable basis, the Shuttle sold well against Ariane.

While it is mostly unneeded, there have been occasions when separate launch financings are required. NASA should be allowed to provide out of its funds partial launch financing for its customers on the basis that any commercial vendor might provide. However, I recommend it be limited to cases where another Government organization, such as the Eximbank or AID is providing the major portion of the support and is aware of the NASA portion.

The cross-border tax lease, extensively used in commercial aircraft export, has as yet not been employed in financing satellites. However, it is only a matter of time until this structure will be used. Essentially, U.S. taxpayers would reduce their taxes through depreciation and investment tax credit allowances while leasing to foreign users. For an entry level communications satellite system, which would consist of two in-orbit satellites and a spare on the ground, the tax subsidy would provide a "free ground spare," approximately a $50 million or 15-20% reduction in price. The thickness of the tax benefit market in the United States gives a potential U.S. exporter substantial competitive protection against adverse U.S. currency value movements and subsidized competitors. The proposed Pickle-Dole leasing legislation before the House and Senate would make this subsidy unattractive or unavailable to exporters. In my opinion (not necessarily Citicorp's) restrictions under this proposed legislation should not be applied to exports as long as there is a minimum (perhaps 50%) U.S. content in exported space systems as measured C.I.F. in orbit. The lost Treasury revenue would be offset somewhat by the taxes collected from otherwise unemployed people involved in manufacturing the exported system.

Counter-trade or offsets are requirements to purchase exports or make technological investments purchasing countries. This practice and capability are frequently necessary in aerospace exports. At present neither NASA nor potential exporters with moderate capitalization have the ability to provide these services effectively. Many believe that NASA lost the competition for providing launch services for the Brazilian satellite system due to an attractive offset arrangement offerred by Arianespace. I believe that NASA with the support of the Department of Commerce, Office of the Special Trade Representative, or the proposed Department of Trade should develop mechanism to support (on a financially self-supporting basis if possible) a countertrade or offset support mechanism.

Finally, there is the issue of possible cross-subsidation of products. If a "superior" (low cost space segment) U.S. system had to compete against an "inferior" system (higher cost segment), the U.S. supplier could be underpriced if the competitor could offer low cost ground segment on a "bundled" basis. An example could be the export of direct broadcast satellite systems where the value of the ground segment is high relative to the space segment. Motivation for maintaining the technology for producing low cost ground equipment rightly belongs in the private sector. However, NASA should develop certain underlying technology to enable the private sector to develop what it can within its own resources. An example of such a direction is NASA's research effort in the 30/20 ghz area.

Development Support for Entrepreneurial Activity

As mentioned earlier, the single biggest barrier to entrepreneurs is the high cost of doing business in space. Most early stage venture investments are under $15 million, far less than the cost of a single Shuttle ride. To induce "undercapitalized" entrepreneurs to develop space businesses, the Government should provide the infrastructure for commercial development of space, including in certain cases--demonstration projects, but should not attempt to develop commercial ventures. The Government cannot reasonably anticipate commercial product applications as well as in-place marketers. NASA should devote its commercialization activities to supporting developments requested and partially paid for by the private sector and other Government agencies. An example of such a service would be providing low cost payload integration services. NASA should, as a rule, initiate developments toward improving its own space and aeronautical capabilities.

The Government should invest indirectly in new technologies by building and maintaining the supporting infrastructure that will allow the new technologies to develop. Examples of this type of supporting investment would be technology procurement and operation of materials testing facilities and support; low-cost, accessible, predictable, transportation; space platforms; a space station; and low-cost easily available information on non-security related technology developments.

Except in the most unusual circumstances, the Government should not have as its goal a conventional measure of return on investment in revenue generating activities. A venture that could not attract risk capital from "normal" sources would most likely provide poor returns to the Government as well. If there were extraordinary pressure placed on the Government investor to show some early measure of financial success on a return on investment basis, the

Government investor would be forced to compete with commercial sources for the most attractive investment. Consequently, the Government investor would have avoided the long term "infrastructure" investments that would have been needed to allow a true venture capital environment to develop.

In summary, I believe NASA and other portions of the Government have the in-place capability to significantly help commercialization. Most of my suggested added functions are, if not within, closely related to NASA's existing charter or capabilities. However, it should be accepted that NASA should have a de facto operational role in certain programs prior to their transfer to the private sector. NASA should be allowed to perform this role as effectively as possible and, where possible, to generate revenue to partially support infrastructure activities.

This ends my statement. Thank you.

Mr. VOLKMER. Thank you very much, Mr. Simonoff.

The gentleman from Virginia have any questions?

Mr. BATEMAN. Mr. Chairman, I do have one, but I'm afraid we're running out of time——

Mr. VOLKMER. We don't have second vote yet.

Mr. BATEMAN. The one question that I had was your reference to the countertrade and the "attractive offset arrangement offered to Brazilians by Ariane Space."

Very quickly, what were the "attractive" things that were offered?

Mr. SIMONOFF. I understand [I don't—I've heard and I] NASA perhaps has been closer to the market. It was a long-term, low-interest loan of some sort. I don't know the specifics of it.

Mr. BATEMAN. OK.

That's all.

Mr. VOLKMER. All right, I have a couple——

Mr. SIMONOFF. Excuse me, might I add, though, the one thing that—that as far as I'm concerned—from my observation of Ariane, Ariane has competed fairly with regard to financing and they've pretty much played by the rules.

Mr. VOLKMER. Now, as I understand, you believe that the space program, as we look to the future design and operated for transfer to the private sector wherever possible. Is that correct?

Mr. SIMONOFF. Uhhuh.

Mr. VOLKMER. And why do you make this recommendation?

Mr. SIMONOFF. Simple, because the more of the—the more activities in the space—the more activities in the private sector, the more income generation in the private sector, the greater the ability to draw investment, the more taxes to be paid, and the greater funding that—for NASA to do other things, but also, that's a two-edged sword. What I'm also saying is that you cannot precipitously dump things into the private sector that are in NASA and NASA is going to have to stay involved for many years.

Mr. VOLKMER. In other words, you don't necessarily see private sector control of the space programs, then? In the immediate future?

Mr. SIMONOFF. Such as operating the ownership of the shuttle?

Mr. VOLKMER. Yeah, and operating the shuttle and operating launches, everything.

Mr. SIMONOFF. Well, they can—certainly there are—they can operate—the private sector has proposed to operate expendable launches and——

Mr. VOLKMER. All right.

Mr. SIMONOFF. If this can be done, that's fine, I have no objection to that, but I think in today's environment, I think it would be unrealistic to expect the private sector to take over ownership of the space shuttle.

Mr. VOLKMER. Twenty-five years from now?

Mr. SIMONOFF. Possibly, if the technology is such, that the costs of the shuttle are relatively low and you can enter into these things—enter into these investments, then 25 years from now, sure, with proper regulation for traffic control.

Mr. VOLKMER. In the Space Act, there's—at least one member, maybe others. I know this subcommittee and other people have said policy statements should be included to provide basically that NASA should try to commercialize wherever possible. You believe that that would be helpful to put that in the Space Act?

Mr. SIMONOFF. I believe it would. I believe—wherever possible and wherever reasonable.

Mr. VOLKMER. But there's nothing in the Space Act that right now inhibits promotion of commercialization or private industry.

Mr. SIMONOFF. No, not that I can see. The NASA presence, in any case, gives credibility to potential investment or potential lending as the case may be. Again, what's key is that so long as the projects remain large, the funding and the system designs are going to be constrained by the conservative horizons of the debt sources which must be there in order to enable investors to reach their target rates of return.

Mr. VOLKMER. Now, we don't necessarily see that in communications satellites because——

Mr. SIMONOFF. Oh, yes, absolutely. You see it especially in communications satellites. An example, what you have in a communications satellite is a trade-off in—in the amount of—well, it can be roughly said, the less performance, the less added value that a company has to provide in operation of the communication satellite, the more debt can be attracted.

For example, if you had a standard communication—C-band or KU-band communication satellite where somebody formed a company, presold the transponders, went to an experienced company to do the station-keeping and said, "OK, everybody buys his own transponder, does his own ground networking." This can be financed very heavily by debt.

If you go on the other side to a direct broadcast, a high-powered direct broadcast satellite, where the costs are high, as they are in the other, but there's no assurance of revenue because a lot of the ability of the satellite to generate revenue depends upon the programing that's on there, depends upon whether the public will accept it, and is also based on the discretionary attitude of the public, whether they'll continue to accept it. In these early stages, I doubt that you'll see much debt financing and support of the systems, which means that it would have to be all equity, which means that for the high-power side, only a well-capitalized company could support it and a startup company would have an extraordinarily difficult time doing the financing.

Mr. **Volkmer**. I have a vote on and I'm going to have to leave. I have additional questions.

[Answers to questions from Mr. Simonoff follow:]

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Jerome Simonoff
Vice President

November 21, 1983

Honorable Harold L. Volkmer
Chairman
Sub-Committee on Space
Science and Applications,
Committee on Science and Technology
U.S. House of Representatives
Suite 2321
Rayburn House Office Building
Washington, DC 20515

Dear Mr. Volkmer:

Enclosed are the answers to the additional questions that you sent to me. In addition, I have sent the corrected testimony to Lynne Draper.

As I mentioned during the testimony, it was an honor for me to have appeared before your committee. I hope in the future, your staff should feel free to call me if I can be of any help.

Sincerely,

CITICORP

1. Q. Your statement is based on the fundamental position (stated on Page 1) that "space programs should be designed and operated for transfer to the private sector whenever possible."

Q. -- What are your reasons for making this recommendation?

A. The reasons for making this recommendation are :

1. Once in the private sector, or in the public sector with financial support from the private sector, growth of space applications would become independent of Federal budget limitations. Worthwhile long-term applications would not be limited by the necessity to control substantial budget deficits.

2. Private sector focus is especially important for contributing to modernizing the economy.

3. Investment by the private sector, as opposed to the public sector, should provide a greater number of smaller investments. The likely result would be a greater chance for some economically successful programs.

4. The growth of the commercial sector of the economy in space would increase tax revenues.

Q. -- Why do you believe private sector control is desirable? How would this help our national space program?

A. "Whenever possible" means that the private sector control is not necessarily desirable in all cases. The Federal Government must participate to: (1) push technology when costs are greater than private industry is able to bear (for example the 30/20 GHZ communication technology), (2) transfer "unclassified" defense developed technology to the private sector, (3) provide industrial infrastructure support to lower entry level costs into space for entrepreneurs.

Q. -- What proportion of our space program do you believe could be transferred to the private sector, say, over the next 25 years?

A. Most portions of today's space program are probably not transferrable. I believe a small, second generation space station and, perhaps, some remote sensing applications would offer possibilities. More important, I believe that the technology developed under programs will be transferrable over many years as opposed to the programs themselves. I do not believe it is appropriate to expect functions that are customarily government functions such as weather forcasting, national defense, or national safety programs to be transfered to the private sector.

Q. -- What conditions must exist to allow successful transfer of government space programs to the private sector (e.g., proven technological capability, developed user community, mature market place and demand)?

A. More important than the transfer of government space programs is the underlying technology. The conditions for successfully transferring the technology involve its reasonable access by the potential user community, i.e. avoidance of undue classification, and availability at low cost. If the process of absorbing the technology is too expensive for private industry, then NASA or the Department of Commerce should use an education process similar to that of the Department of Defense whose procurement contracts enable companies to acquire technology. If, on the other hand, technology such as space transportation is not readily transferrable, then the program should be treated as a national resource with the government subsidizing its use.

With regard to the transfer of an existing government programs to the private sector, I believe all the factors listed in the question are important for transfer. However, I am skeptical about the ability to truly transfer operating government programs. Most systems are not designed for commercial applications. The sale of a large system to the private sector with a government subsidy is not really a transfer. It is analogous to the government hiring a contractor to manage a program. With a subsidy, no responsible government official will allow a program to operate without protection of the government's interests. Consequently at best, the government would be an entrepenuer. At worst, the government would clash with the entreprenuers attempting to run the system.

2. Q. The private sector is clearly becoming more interested in space. President Reagan's 1982 space policy stated that one of its goals is to "expand U.S. private sector investment and involvement in civil space and space-related activities." Would the addition of this kind of language to the Space Act give the private sector confidence to spin greater commercial activity in space?

A. I don't believe the addition of the language posed in question two would materially encourage or discourage the private sector from participating in space related activities. What is more important, is the ability of NASA and other government agencies in execution of their functions on behalf of private industry's efforts, and the commitment of the government to provide support of specific programs such as low cost transportation. This would mean, that the government may choose to deliberately limit the Space Shuttle's revenues to keep users' costs down which would, in turn, preclude ultimate recovery of the Shuttle's full costs.

3. Q. Your statement recommends that NASA get into the insurance business, to protect against losses from launch failure and life. If NASA is providing the risk analysis, what advantages are there in the government providing the insurance over the insurance industry?

A. My statement recommends that NASA extend certain insurance functions that it already is allowed to perform in the liability area to provide a backstop in case of insufficient insurance underwriting capacity. I feel strongly about this recommendation because I am advised by underwriters and brokers in the space insurance industry that their has been a cumulatively unsatisfactory record of profitability in insurance underwriting. The risk faced by potential commercial users is that one or more major launch failures may cause a shrinkage in this market.

There is precedence for my concern about shrinkage or the insufficiency of insurance underwriting capacity. Several years ago, Lloyd's of London through various brokers provided insurance to protect leasing companies from losses due to erosion of rental values of IBM mainframe and peripheral computing equipment. The insurance policies were overused. When IBM introduced equipment with advanced technology, substantial payouts resulted. Lloyd's underwriters subsequently withdrew from the IBM mainframe residual risk market. Today, for computing equipment, it is possible to obtain such insurance for certain peripheral equipment but in amounts that are a small fraction of those that were available when the Lloyd's insurance was available.

An example of government support when there is insurance insufficiency can be found in Japan. In this case, there is insufficienct commercial capacity for earthquake insurance. Consequently, the Government supports the insurance market.

I believe NASA is uniquely qualified to provide risk analysis for assumption of an underwriting role. I do not believe that there is any advantage of having NASA assume the insurance role in place of private industry. However, in the absence or deficiency of private industry capacity, I believe that NASA could perform this function extraordinarily well.

4. Q. You state (p.3) that "As additional commercial insurance coverage becomes available, NASA's coverage would be replaced by the user." When and under what conditions would additional commercial insurance become available?

A. Hopefully, NASA would never have to supply insurance because the commercial market would be adequate. Additional coverage would become available when, after a period of deficiency, there is a period of successful launch history at premium pricing that would allow underwriters to have achieved profitable operation.

5. Q. On page 5 you recommend NASA consider counter-trade or offsets in export trade, as a way to enhance US. competition for providing launch services abroad.

Q. -- How should NASA go about doing this?

A. NASA, in support of its or payload vendors' marketing efforts, should identify where offsets are needed. NASA should then refer the execution of the offset program to other agencies in the government.

Q. -- Should NASA be working much more closely with other agencies involved in foreign policy? Would NASA be the "lead" agency in these efforts?

A. NASA should not develop a bureaucracy to perform offsets since other agencies such as the Department of Commerce or the Office of Special Trade Representative should have in place substantial existing capability. Clearly, in support of a space marketing effort, NASA should be the "lead" agency in these efforts. To allow another organization to autonomously execute without allowing the NASA marketing organization to view the trade-offs of countertrade against other space marketing issues, could thwart the value of the countertrade effort.

Q. -- Do you believe offset mechanisms are more attractive than if NASA were given a "marketing" budget to promote the Shuttle internationally?

A. I believe the offset mechanism should not be viewed as a trade-off against an international Shuttle "marketing" budget. The offset program should be financially self-sustaining. Furthermore, the availability of an offset should be part of a marketing budget, not something "in lieu of."

Also, in viewing a marketing budget in general for international Shuttle promotion, it is inconceivable to me that any buyer organization that is planning to invest the necessarily large sums of money in a space project would not already be well aware of the Shuttle's capabilities. The Shuttle marketing organization will be dealing with sophisticated buyers who, given the amount of money to be spent, should take extraordinary efforts to learn about the important issues involving Shuttle launching. What should be important in international marketing and promotion is the ability of NASA to help potential users understand how to use the Shuttle and to assure them that NASA can deliver on its promises for a timely and economical launch.

Under Lt. General Abrahamson's management, NASA's transportation organization has become a competitive rather than a passive supplier of launch services. In spite of the organizational problems that General Abrahamson has had to deal with, NASA has become relatively responsive to user's needs. In spite of the high degree of promotional professionalism shown by Arianespace, NASA has been able to effectively compete and has won most competitions against Arianespace.

I believe the competitive role of NASA has been of extraordinary benefit to space commercialization. By choosing to be competitive, NASA has had to become responsive to user needs. For successful commercialization in the future, responsiveness of NASA to business rather than just technological issues will be crucial to development of commercial space.

6. Q. Your statement is fairly clear that while NASA should foster commercialization it should not develop commercial ventures. What about NASA's role in operating the Space Transportation System? Should NASA manage Shuttle operations and utilization or should this be given to the private sector?

A. As long as the Shuttle has a national defense mission, it is unrealistic to believe that ultimate responsibility for the operation of the Shuttle could be in any other hands than the U.S. Government or, specifically, NASA. To the extent possible and beneficial, NASA should rely on private industry to support its marketing and delivery of launch services. However, NASA cannot totally transfer this responsibility in the forseable future.

7. Q. Can you comment about the relative costs the private sector and government should bear in tests and demonstrations? Should we develop some standards or criteria which might be reflected in language in the organic act, so that relative cost contributions of government and the private sector could be anticipated?

A. NASA should absorb those costs necessary to minimize the transportation costs of a payload. This includes, the transportation itself, payload integration, and flight qualification. Furthermore, NASA should absorb costs that require unique instrumentation on the ground for which NASA has developed and infrastucture such as materials and antenna radiation patterns among others. Private industry should bear the cost of payload development with regard to design and fabrication, and fabrication and transportation cost with regard to revenue producing applications. I believe it is too early to modify the organic act to specify cost sharing at this time. I would allow a period of experimentation in the commercialization process to allow the issues to surface before I would recommend modifying the organic act.

8. Q. Escalating costs in development and manufacture of payloads and spacecraft and transportation to orbit pose the greatest barrier to use of space, expecially for the commercial sector. What can be done (by NASA) to allay this problem? Are there incentives NASA should consider?

A. I would recommend that NASA make a public commitment to a certain amount of excess transportation and insurance underwriting capacities to allow long term debt financing and investment to be made in returnable payloads. I would also encourage investment in technologies that would encourage development of a export industry. An example of such technology is the 30/20 gigerhertz communication capability. At this time, I would discourage the use of any tax incentives by NASA that are not already available to the private sector in non-space related activities. I would avoid a condition where investors might be attracted to placing funds in ventures that might have only marginal degrees of success, but provide attractive tax shelter.

[Whereupon, at 12:45 p.m., the subcommittee was adjourned, to reconvene, subject to the call of the Chair.]

REVIEW OF THE NATIONAL AERONAUTICS AND SPACE ACT OF 1958

WEDNESDAY, OCTOBER 26, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Space Science and Applications,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:41 a.m., in room 2325, Rayburn House Office Building, Hon. Harold L. Volkmer (chairman of the subcommittee) presiding.

Present: Representatives Volkmer, Fuqua, Brown, Nelson, Andrews, Winn, and Lujan.

Staff present: Darrell Branscome, staff director; Lynne Draper, hearings coordinator; Lillian Trippett; Joyce Freiwald, minority technical consultant.

Mr. **Volkmer**. The hearing will come to order.

Today we conclude the hearings of the Subcommittee on Space Science and Applications on the National Aeronautics and Space Act of 1958.

We are most pleased to have in our midst the current and three former Administrators of NASA. The current Administrator, Hon. James Beggs, will present his testimony. He will then be followed by a panel of three of his predecessors.

We welcome him and also Dr. Robert Frosch who served as NASA Administrator from 1977 to 1981. Dr. Frosch now serves as vice president of the General Motors Corp.

James Fletcher also joins us today. Dr. Fletcher was NASA's Administrator from 1970 to 1977. I know that you have been very busy with a heavy consulting agenda, Dr. Fletcher, and I am pleased you could join us today.

Finally, we welcome Thomas Paine who served as NASA's Administrator from 1968 to 1970, and who is the former president of Northrop Corp.

We are most appreciative of you gentlemen for taking the time from your busy schedules to come to talk to us today. We are fortunate to be able to tap your wisdom and learn from your experiences with NASA and our space program. We hope that from lessons of the past, we can better prepare for NASA's next quarter century.

Before we proceed with the witnesses, I now recognize the gentleman from Kansas, Mr. Winn, the ranking minority member of the full committee.

Mr. **Winn**. Thank you, Mr. Chairman.

I am delighted to sit in on the hearings today. It is always a pleasure to welcome my good friend, Jim Beggs, to the committee as well as my other good friends who have served as NASA Administrators over the time I have been privileged to serve in Congress.

The series of four hearings is an appropriate way to mark the 25th anniversary of NASA. It has provided us with an excellent opportunity to remember the first 25 years of NASA—not only to recount all of the great successes but to remind ourselves of the lessons to be learned from our experiences.

These hearings have also provided us with a perfect opportunity to think about the next 25 years of NASA. We can anticipate that the future will bring more exciting scientific discoveries and more technical advances for the good of mankind.

We have heard in the innumerable examples of technology transfer from NASA to other applications, but recent events have also reminded us of the usefulness of our presence in space as well.

The tragic end of the Korean Air Line's flight 007 demonstrated the value of using space navigation capability for international airlines.

Another similar example is the space-based search and rescue capability. I anticipate that NASA will continue to provide top quality research and development for the benefit of all, long into the future.

As we consider the future, we have also been thinking about the Space Act, how long it has served us and if it can continue to provide the framework for the space program. Although it is likely that there is not a pressing need to change the Space Act now, it is still a good idea to review it.

I look forward to the testimony of our witnesses this morning and thank you, Mr. Chairman.

Mr. VOLKMER. Thank you.

I now recognize the gentleman from New Mexico, Mr. Lujan.

Mr. LUJAN. Thank you, Mr. Chairman.

During the last three hearings, we have heard some excellent testimony about the future direction of the U.S. space program. I believe, along with most of our witnesses, that some form of a space station is the next logical step in space, with the eventual exploration of the solar system and, if possible, the universe, as NASA's ultimate mission.

All of this requires a space transportation system that is selectively cheap and reliable. This committee has shown itself to be a dedicated supporter of the space shuttle program. No one can watch a shuttle launch without thrilling to the spectacular technical achievement the shuttle is.

As it approaches operational status, the shuttle is showing itself to be a vital element in maintaining this Nation's lead in exploiting space. I, myself, can envision the day where there are a variety of different space transportation vehicles and facilities. There will be vehicles for moving from low earth orbit to geosynchronous orbit, and perhaps vehicles for manned interplanetary travel. The present shuttle would someday be replaced by a variety of shuttles—some for carrying large or heavy payloads, some for quick turnaround, and maybe some for carrying a cargo of passengers like today's commercial airlines.

Our present aircraft technology has given us a fleet of various special purpose vehicles, and I see no reason why this should not happen in space as well.

But we are certainly not there yet. The shuttle is still an R&D vehicle in some ways, as much as we would all like to see it as a truly operational system. But the day will come when the shuttle can claim operational status. We should start planning for that day now.

We must recognize that no operational element in our space program should be totally immune from market forces. This has not been the case with ELV's and will not be the case for the shuttle. We do not and cannot expect a space transportation system that has been developed at Government expense to be protected as a monopoly from private ventures. We all know that could be a very dangerous precedent.

Last week's testimony included suggestions for a separate part of NASA for shuttle operations. I think this is an extremely good idea and the logical next step for space transportation systems.

In addition, we should plan for minimizing the subsidy in space transportation systems—whether this is the shuttle or the Ariane. If there was a clearly defined schedule of prices until the shuttle price reaches full cost recovery, industry would have less uncertainty to deal with. The French are not going to subsidize the Ariane any more than necessary to compete. If we raised our prices, the French would raise theirs.

Another step toward the future is to start thinking now about the space vehicles of the future—the orbital transfer vehicles and the next generation shuttle. These are all part of NASA's role as an R&D agency.

I look forward to hearing from today's witnesses on these and other issues.

Thank you, Mr. Chairman.

Mr. **Volkmer**. Thank you, Mr. Lujan.

I now recognize Hon. James Beggs. Your statement will be made a part of the record. You may either summarize it or review it in full, however you so desire.

STATEMENT OF HON. JAMES M. BEGGS, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. **Beggs**. Thank you, Mr. Chairman. I do have a brief summary that I would like to read, if I may.

Mr. Chairman, Mr. Winn, the 25th anniversary of NASA is a good time for us to reflect on the National Aeronautics and Space Act which served the Nation so well in the past and, I am confident, will continue to serve us in the future. Clearly, it has been in the national interest to conduct a broad program in aeronautics and space activities of such a magnitude that it could only be undertaken by the Federal Government.

The authors of the Space Act were men of vision. Enacted during a period of national frustration over the launching of the Sputnik, the Space Act provided NASA with the authority to combine and exploit the management, scientific, and engineering resources of Government, industry, and the Nation's universities. This unique link of the public and private sectors enabled NASA to undertake goals as diverse as exploring the solar system and the universe; expanding knowledge of the Earth; developing new technologies for space and Earth application; realizing the military potential of space; building national prestige, and promoting international cooperation in space.

Our Nation's accomplishments in space research and technology over the past 25 years have demonstrated how the scope and flexibility of the Space Act has permitted and encouraged diverse scientific and technological achievements. The Nation's space program has progressed from the first faltering attempts to launch a spacecraft successfully, to the first manned Mercury flights, to the Apollo lunar landing and now to the space shuttle and the possibility of permanent manned presence in space.

In space science, we have progressed from the grapefruit-sized Explorer 1 with its simple experiments to complex spacecraft like ISEE and the solar maximum mission to study the Sun and its relationship to the Earth; the Viking lander to study Mars; Pioneer and Voyager to study the primordial outer planets, and the HEAO, IRAS, EUVE, and Space Telescope to study the universe.

In aeronautics, we have continued the NASA tradition to keep the U.S. preeminent in civil and military aviation. We have been able to apply the knowledge and technology acquired in space exploration to programs which directly benefit people on Earth with weather satellites to study the atmosphere; remote sensing satellites to study the oceans and the Earth; materials processing in space; and satellite communications, a new industry which was spawned by NASA space activities.

We have been able to assist other Government entities like the military in sensor and launch vehicle development; NOAA with weather and remote sensing technologies and the Department of Energy with applied space technologies to help solve energy problems. Apollo-Soyuz, spacelab, and many other planetary and scientific spacecraft demonstrate the success of international cooperation in space.

The Space Act has stood the proverbial "test of time" well and with great vitality. That vitality still exists and the U.S. space program will continue to thrive into the future. The Space Act is structurally sound and should be preserved in essentially its present form which is well suited to meet the needs of today and the future. If specific changes in emphasis, addition of work, or mission clarification are needed, they can readily be accommodated through the annual authorization process. I believe the Space Act has ample flexibility and authority to meet the future space needs of the Nation even with the increased emphasis on national security, foreign competition and commercialization of space.

NASA's highest priority is to make the space transportation system fully operational and cost-effective in providing routine access to space. With the shuttle providing routine access to space operations, NASA has initiated planning for a potential space station development program. If approved, it would contribute toward ensuring U.S. civil leadership in space, and could be used by all elements of the space program. The Space Act will provide an umbrella for NASA's future programs in science, applications and aeronautics, and for all of NASA's cooperative programs, as they grow in size and importance.

One of NASA's major goals is to expand opportunities for the U.S. private sector in civil space and space-related activities. The Space Act, in my view, provides the flexibility to permit greater private sector involvement in what was once solely the province of Government. Existing NASA programs which reflect the expansion of private sector investment in space include space production of disease-curing products, and the formation of extremely efficient crystals in space. NASA is also in the process of "privatizing" the operation of expendable launch vehicles and service activities in connection with the shuttle, such as the preparation of payloads.

In each of the preceding areas, the Space Act has served us well and I see no reason why it will not continue to do so into the foreseeable future. Supported by the Space Act, the Agency is prepared to continue the Nation's remarkable progress in aeronautical and space activities.

I thank the subcommittee for this opportunity to testify and will be happy to respond to your questions.

Thank you, Mr. Chairman.

[The prepared statement, plus answers to questions asked of Mr. Beggs follows:]

Statement of

James M. Beggs

Administrator

National Aeronautics and Space Administration

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

The 25th Anniversary of NASA is a good time for us to reflect on the National Aeronautics and Space Act which has served the nation so well in the past and, I am confident, will continue to serve us in the future. Clearly it has been in the national interest to conduct a broad program in aeronautics and space activities of such a magnitude that it could only be undertaken by the Federal Government.

Twenty-five years ago, on April 2, 1958, President Eisenhower submitted a special message to the Congress recommending the creation of a National Aeronautics and Space Agency. He listed four factors as having a direct bearing on future progress that required that an imaginative and well conceived space program be given high priority and a sound organization to carry it out. These factors were "the compelling urge of man to explore the unknown," "the need to assure that full advantage is taken of the military potential of space," "the effect on national prestige of accomplishment in space science and exploration," and "the opportunities for scientific observation and experimentation which will add to our knowledge of the earth, the solar system, and the universe." He stated that the program and organization he recommended should contribute, among other objectives, to "the expansion of human knowledge of outer space and the use of space technology for scientific inquiry," and "the promotion of cooperation with other nations in space science and technology." His message stressed that a civilian setting for the administration of the space function "will emphasize the concern of our Nation that outer space be devoted to peaceful and scientific purposes." President Eisenhower also recognized that the new civilian agency should be given the authority it will need "to administer successfully the new programs under conditions that cannot now be fully forseen."

Accordingly, the Congress passed and, on July 29, 1958, President Eisenhower signed the Bill, the National Aeronautics and Space Act of 1958, which created the National Aeronautics and Space Administration (NASA).

The Act, the provisions of which are well known to the Subcommittee, has served the Nation and NASA well. Its scope and flexibility have allowed the country to accomplish all the marvelous scientific and technological achievements with which we are so familiar. The people of this Nation have been the direct beneficiaries of NASA's space and aeronautics activities. And, because of the traditional open nature of the NASA space programs, people everywhere in all geographic areas and at every level of society have shared the thrill of the challenge and fruits of the results.

In my opinion, what has been accomplished so far has been no accident. The individuals who so carefully crafted the Space Act were people of great vision, and they were able to translate vision into the written word with sufficient flexibility to enable the accomplishment of great and lasting human events. The original framers of the Space Act should be applauded for their effort; I believe history will confirm that this was one of the more ingenious applications of the legislative process.

Clearly, the Space Act evolved at a time when those involved with its foundation were under considerable pressure and stress resulting from the initial Soviet efforts. Even so, the product which emerged has stood the proverbial "test of time" well and with great vitality. I believe that vitality still exists as it did in 1958 and that it will continue to thrive into the future.

Mr. Chairman, we believe that the Space Act is structurally sound and well-suited to support today's needs. We recommend that the basic architecture of the Act be preserved in essentially its present form. We are of the opinion that specific changes in emphasis, addition of work which is peripheral to the NASA mission, and clarification of our mission can be readily accommodated through the annual authorization process.

We have found this method of updating the Space Act to be very satisfactory. It serves to avoid speculative structural modifications which could turn out to be unnecessary or prove to have been wrong. Any legitimate interest can be accommodated through this process whether it originates in the Congress, the Executive Branch, or the private sector.

Mr. Chairman, the point I am emphasizing is that when circumstances dictate a need for change, a well understood procedure exists to bring such change about. This should be necessary only infrequently, as has been the case for these first 25 years. I believe the most effective course for NASA to follow is to continue to use its broad legislative mandate in a flexible manner to meet changing circumstances. We will, as I am sure the Subcommittee will, be ever alert to the need for meaningful alterations to the Space Act and will make appropriate recommendations. In the meantime, the Space Act has served the Nation and NASA well, and I perceive no reason why it should not continue to do so as we look to the future.

I will turn now to a summary of NASA's planned space activities for the future. My remarks will be brief, but should illustrate the adequacy of the Space Act in meeting the challenges ahead of us.

NASA's highest priority goal still is to make the Space Transportation System fully operational and cost effective in providing routine access to space. For now, operation of the Shuttle fleet will continue to be a NASA responsibility for several reasons. As Mr. Fink mentioned in his testimony to you, the NASA Advisory Council has recommended that Shuttle operations be divorced from NASA's R&D organization and be placed under a dedicated organization created within NASA to focus on Shuttle operations and utilization, including marketing activities and sustaining engineering. We are examining this concept and a number of variants as a first step in what may turn out to be several steps toward increasing commercial involvement in system operations as the Shuttle reaches full operational maturity.

With the Shuttle providing routine access to space operatations, NASA initiated planning for a potential space station development program approximately one year ago, in order to provide the President and the Congress solid data upon which to base future decisions. If approved, the space station would contribute to ensuring U.S. civil leadership in space, and could be used by all elements of the space program.

Future space operations will require other space transportation systems such as orbital transfer vehicles and may require augmentation by additional capabilities such as heavy lift launch vehicles. Those systems ultimately may be operated partly or wholly by industry and the military, and industry may design and develop some systems that are straightforward in concept and that have high potential demand. However, we expect that NASA will continue to develop and demonstrate advanced technology for space transportation systems and to develop and test systems that involve high technological risks, appear to have limited commercial potential, or are of so large a scope that industry cannot be expected to undertake their development and testing.

One of NASA's major goals is to conduct an effective and productive space and Earth sciences program that expands human knowledge of Earth, its environment, the solar system, and the universe. While science programs requiring orbital operations are currently being coupled closely with the Shuttle, a potential space station development could provide enhanced capabilities for the science program.

A factor being given increased attention is the health of the university community that provides the reservoir of talent that performs, in house and under contracts and grants, a large portion of our fundamental science and technology work. One aspect of the universities' health is the adequacy of their instrumentation and research facilities. We are seeking ways to help ensure that adequacy.

Another of NASA's major goals is to conduct effective and productive space applications programs that contribute materially toward U.S. leadership and security. Present national space policy mandates a climate conducive to expansion of private sector involvement and to management of Federal civil operational systems by other agencies of the Government. Thus the program we are planning covers research, development, and exploration of space applications, and is based on the premise that NASA will continue to conduct the research and development for applications systems such as Landsat, but will not be responsible for their operations.

Since re-entering the communications technology area, we have reestablished a very forward-looking high-technology program in satellite communications. A future program for which we are exploring advanced technology is the Geostationary Platform, which will be an "ultimate" communications satellite providing greater performance and economies. It is of high interest to the military and the commercial community.

With regard to the activities we formerly called materials processing space, we have expanded the scope of the program to include elemental processes--basic physical and chemical reactions in a microgravity processing. With this expansion of the program, we have changed its title to Microgravity Science and Applications, the science precursor necessary for the effective establishment of an industrial materials program.

In aeronautics, NASA has had a continuing close relationship with the national security community and the civil and military aerospace industries. This relationship was built on the heritage of close National Advisory Council on Aeronautics (NACA) and Department of Defense (DOD) cooperation. The guidance provided by the aeronautics policy issued by the Administration last year reaffirmed the principles of that relationship.

With the military role in space growing rapidly, a comparably close relationship is developing between NASA and DOD. Two influences have been particularly significant here: one is the NASA-DOD relationship engendered by the use of the Shuttle; the other is the guidance in the President's National Space Policy statement of July 4, 1982. This policy provides for a strong national security program in space and requires close coordination, cooperation, and information exchange between the civil and national security space programs.

Coordination is maintained at both the working level and the senior official level. NASA and DOD regularly establish working groups to investigate specific subjects of interest to both agencies; a recent example is our coordination with the military on space station studies. Important matters having policy implications progress from the working level to the Senior Interagency Group (SIG) for discussion before referral to the President.

One of NASA's major goals is to expand opportunities for U.S. private sector investment and involvement in civil space and space-related activities, all within the broad powers inherent in the Space Act. When NASA was created twenty-five years ago, what are now our commercialization space industries were in their infancy. Since that time, entire new industries have been created by virtue of NASA's space research and development. The space communications industry being a prime example. As NASA enters its next twenty-five years, the Space Act, in my view, will provide the flexibility to permit greater private sector involvement in what was once solely the province of government.

Industry's interest in commercial space activities is increasing and we are getting progressively more inquiries as we continue to demonstrate NASA programmatic areas with commercialization potential. Areas for possible commercialization currently under discussion with industry include, for example, space production of disease-curing products, formation of extremely efficient crystals in space, and expendable launch vehicles and service activities in connection with the Shuttle, such as the preparation of payloads.

There are several aspects of NASA's role in encouraging expanded private sector investment in space. The first is the development of the science and technology fundamental to the industralization of space. Another area in which NASA has a role is that of providing opportunities for the private sector to gain access to space and, once there, to use space effectively and economically as a resource for commercial ventures. The third area in which NASA will continue to have a role is development of capabilities beyond those available to the private sector or those which the Federal Government must possess to carry out its broader role in space. A fourth area in which I believe NASA a role is that of turning over to the private sector the operation of systems NASA has developed.

Approximately one year ago, I asked the National Academy of Public Administration (NAPA) to examine the overall question of NASA's role in the establishment of commercial operations in space. The results of that study, described to you in your May hearings, led me to set up an internal task force with the responsibility to develop policies and procedures to govern NASA's involvement in private sector commercialization and to provide guidance on possible organizational steps that should be taken to carry out those policies. This task force is to complete its work late this year, and we will report to the Congress on its results as soon as I have had an opportunity to review them and to determine what follow-on steps are needed.

The national space policy also reaffirms the Space Act's commitment to cooperation with other nations in space endeavors that are in the national interest and in maintaining the freedom of space for activities that enhance the security and welfare of mankind. NASA has a rich history of international cooperative projects which have greatly expanded our scientific knowledge while promoting a sharing of costs.

The space programs of a number of other nations and that of ESA have reached a level of maturity that has increased the significance of scientific, technological, and applications competition in the equation governing our international activities. In all our activities we strive to protect U.S. technology, and will continue to do so in the future.

In each of the preceding areas, the Space Act has served us well and I see no reason why it will not continue to do so into the foreseeable future, consistent with our vision of the directions NASA will take in that future. I believe that same message can be derived from the testimony of most of the witnesses who have preceded me during these hearings.

Supported by the Space Act, the Agency is prepared to continue the Nation's remarkable progress in aeronautical and space activities.

I thank the Subcommittee for this opportunity to testify and will be happy to respond to any questions.

Written questions requested during the October 26, 1983, hearing at which Mr. Beggs testified on the Space Act of 1958.

QUESTION A-1:

We have been discussing possible language amendments to the NASA Act concerning NASA's promotion of commercialization of programs proven by research and development. Do you believe this kind of language would help recognize NASA's potential contributions in this area, and perhaps help reduce fears of risk in the private sector to spur increased commercial ventures in space?

ANSWER A-1:

NASA does not feel that any amendment to the Space Act is legally necessary in order to engage in or to encourage the commercialization of space.

QUESTION A-2:

How do you view NASA's expanding role in operations and commercialization will affect the Agency's research and development mission? Are these missions competing or complementary?

ANSWER A-2:

As we exploit the capabilities of the Shuttle, we have made available and have access to critical and new research opportunities. Approximately seventy research experiments are being flown on the next mission. We are also furthering our knowledge of space science and applications with the tasks conducted during each mission.

At the present time, these missions are complementary. As the Shuttle technology matures, we believe it is critical that NASA reexamine its role in Shuttle operations and utilization.

QUESTION A-3:

Your testimony suggests that NASA's major role in commercialization is one of continued research and development into applications areas. Do you feel that NASA is the appropriate Agency to undertake economic stimulus and promotion of space related industries?

ANSWER A-3:

Like many other industrial activities, space commercialization ventures are engaged in a search for technologically innovative products and services which are risks associated with such undertakings. Reducing these risks is necessary if commercial space endeavors are to attract private investors.

The technology for making most space activities immediately profitable is not yet available. NASA needs to continue its research in areas of priority to U.S. industry. This is the best way to reduce technical risks and allow industry to assess profit opportunities.

Government has not traditionally been attuned to considering product/profit potential associated with its research and development activities. NASA will strive to create vigorous, useful mechanisms tying Government, industry and academia together in cooperative research relationships. These mechanisms clearly need to be institutional as well as technical. Examples are (1) a combined aerospace and nonaerospace industry research liaison to advise NASA on appropriate policies, research priorities, and experimental facilities to support U.S. industry in space-related commercial ventures, (2) co-sponsored NASA/industry research programs at universities and research activities, and (3) an expanded NASA space experimentation program in which industry and university researchers will be the principal investigators.

In addition, NASA can help reduce commercial space venture start-up risks by providing a stable environment with known decision points. NASA will strive to do this by: making experimental facilities available; entering into joint endeavor agreements; and establishing easier and more timely access to the Shuttle for commercial payloads.

QUESTION A-4:

You have indicated that NASA will encourage expanded private sector investment in space by providing opportunities for the private sector to gain access to space.

In a letter to you from the OMB Director dated June, 1982, Mr. Stockman stated "it should not be assumed that the U.S. Government should have responsibility to fund an operational system with sufficient capacity to meet non-U.S. Government needs once the Shuttle technology is developed".

Is there a conflict here in how NASA's role is viewed? Can you comment?

ANSWER A-4:

I believe that many of the greatest benefits this country will gain in the future will be as a result of new ideas that are already blossoming in the private sector. Many of these involve considerable risks, inherent in bold new technology. And the best inducement we can offer is easy access to space. Here, I am referring to new services and new activities in space, such as materials processing. The opportunity to develop and conduct these new services in space was one of the reasons the United States embarked on the Space Shuttle program, and it is just about to start paying off. So, I believe it is important that the space transportation system has the capacity to allow us to continue to encourage private entrepreneurs.

Regarding the OMB Director's letter of June, 1982, I believe there is not a significant difference in our objective. We are already relying on private capital to develop and provide continuing services that are a fundamental part of our commercial space transportation activity, such as upper stages for communications satellites and flexible platforms for materials processing in space. Additionally, our pricing policy doubled in 1986 to allow us to charge the incremental cost of commercial operations to the private sector. Further, our plans are to expand that pricing policy to one of full cost recovery by 1989. We hope to accomplish that without major price increases by reducing the cost of Shuttle operations. The baseline program supports a flight rate capability of 24 per year which allows for considerable non-Government utilization.

QUESTION A-5:

a. Do you have any comment about the recommendation that NASA should boost its efforts to explore the solar system and take a lead role in earth sciences? Is this NASA's "new frontier"?

b. The Council also recommended a new organization within NASA be established to manage Shuttle operations and utilization. Can you comment? Can you compare this with another proposal we've heard that a joint NASA/DOD Shuttle management office be established?

ANSWER A-5:

a. NASA expects to continue to play a leading role in the exploration of the solar system. Our plan for future exploration of the solar system contains two interrelated parts. The first involves exploration of the solar system not only for pursuit of scientific knowledge but also aimed toward the eventual goal of utilizing the resources and knowledge of space for human benefit. The second brings a planetary perspective to our planet aimed at understanding those processes involved in global surface and atmospheric change.

Development of the capability to move at will through the solar system has meant not only an immense expansion of our scientific knowledge of the planets but is also a source of significant national pride. During the past twenty years, the United States has been the undisputed leader in such exploration. Other countries are now beginning to offer a significant challenge to the United States. The Soviet Union is pursuing an aggressive program and is expected to conduct a variety of innovative missions over the next decade. The European nations are entering the field for the first time, as are the Japanese.

The utilization of extraterrestrial resources may eventually be a product of our exploration efforts. Our efforts to date indicate that potentially rich sources of minerals and other elements may be available on the moon and in asteroids. While the economics of extraction of these extraterrestrial resources is unclear today, the initial exploration to determine the source and extent of those resources must be initiated.

In the area of earth sciences, NASA believes that a major effort should be devoted to the study of the earth as a system. The goal of such a research program would be to understand long-term physical, chemical, and biological trends and changes in the earth's environment, including its atmosphere, land masses, and oceans. The concept was put forward last year at UNISPACE as the Global Habitability initiative. The principal contribution of NASA to this research effort could be the exploitation of space to obtain fundamental data on the atmosphere, oceans, land surface, and biosphere on a global basis. In this sense NASA would expect to play a lead role in the earth sciences; and we view it as a natural extension of the programs that we have carried out in the past. The "new frontier" aspect of the concept would be the interdisciplinary nature of the research.

b. The NASA Advisory Council recommended that a new NASA organization be created at the appropriate time within NASA to focus on Shuttle operations and utilization.

We agree that this is an appropriate step, and our contractural and organizational actions within the Agency are geared to move in this direction as rapidly as the maturity of the Shuttle program will allow. For example, we have already consolidated two major Shuttle contracts at the Kennedy Space Center (KSC) and gained benefits, both from the competition and a simplified Government management activity. We recently released a Request for Proposal to gain similar benefits for Shuttle solid rocket motor refurbishment activities at Kennedy. We have also announced our plan for a similar consolidation of Shuttle contracts at the Johnson Space Center. All these actions are designed to reduce Shuttle operating costs, as well as to allow the eventual creation of a more dedicated Shuttle operations organization (should that prove to be the best course), which can be reviewed separately from NASA's traditional research and development mission. This should allow a focused Shuttle organization to better serve Government and commercial space transportation needs, while preserving NASA's ability to dedicate both manpower and budget resources to the advancement of aeronautical and space technology. To insure that the Nation's security needs in Space are fully supported, this dedicated Shuttle operations activity could well include joint management elements with the Department of Defense.

QUESTION A-6:

We have heard from several witnesses that the most important thing NASA should do to encourage commercial activity is to reduce the cost and improve the reliability of transportation to and from space.

a. Do you have any comments about how NASA might reduce launch costs?

b. In 1986, when NASA begins to move away from subsidized prices, Shuttle user charges will double. How will this affect space commercial activity?

c. Do you believe the 1958 Act should contain language concerning Shuttle pricing policy as a means to enable the private sector to anticipate its cost share?

ANSWER A-6:

a. As you know, NASA is taking every possible step to support the national goals set by President Reagan in July, 1982, one of which was to make the STS a reliable, cost effective system. In October, 1983, we took a significant step by consolidating our launch processing contracts at the Kennedy Space Center (KSC) into a single contract. As a significant portion of launch costs are associated with integration of payload and Shuttle systems, NASA has announced plans to similarly consolidate a group of eight contracts at the Johnson Space Center on a competitive basis; this should reduce those costs. Additionally, as we complete key facilities at KSC and increase our launch rate, Shuttle costs per launch will be dramatically reduced. In addition, the production contracts for the external tank and solid rocket boosters are being converted from cost type to incentive contracts in order to better stimulate cost reductions. The actual impact of these actions on the cost per launch to our customers, while not identifiable today, will be included in the development of our pricing for 1989 and beyond.

b. We do not anticipate any specific problems in 1986 as we are currently marketing STS launch space in this time frame. Additionally, the Agency plans to continue using cooperative agreements where the U.S. Government can benefit from technology derived from commercial activity, using mechanisms such as joint endeavor agreements now available to industry. The potential commercial expendable launch vehicle ventures are limited in attracting a different weight class and payload configuration compared to the Shuttle. As I have said before, the commercial ELV will complement the U.S.'s leadership in space rather than directly compete, and NASA has no plans to unfairly compete with the potential commercial ELV operators.

c. Shuttle pricing policy is revised periodically at previously announced intervals to reflect changes in cost and other changes in circumstances. To include rigid prices or policy in the Space Act would limit our flexibility to respond to events that require a change in pricing policy. We believe that our customers presently have reasonable notice of Shuttle prices and knowledge of how long prices will hold.

QUESTION A-7:

A witness from Citibank yesterday recommended NASA consider counter-trade or offsets in export trade as a way to enhance U.S. competition for providing launch services abroad.

Could NASA consider doing this? How would you compare using offset mechanisms versus giving NASA a "marketing" budget to promote the Shuttle internationally?

ANSWER A-7:

Offset requirements are frequently a fact of life in international trade, although in some instances they have been specifically banned, as in the GATT Agreement on Trade in Civil Aircraft. NASA has encountered such requirements in only two of its international launch services negotiations to date. In one instance, a 100 percent offset requirement was levied, which we felt was unmeetable. We lost the competition, but believe that the offset situation was not the decisive element. In another case, we committed to a thirty percent offset objective. Recognizing that our ability to generate offset credits directly is limited under Federal procurement regulations, that commitment was made after consultation with key STS contractors, who have offered their support to us in meeting the objective.

Our experience to date indicates that offsets are only one factor in a broad range of considerations. In most cases, a vigorous marketing effort on all fronts will be more important to success than this single element.

QUESTION A-8:

You have also suggested that NASA "develop the science and technology fundamental to the industrialization of space." Are you suggesting that there are some areas that could realize commercial potential, or "pay-off" if more research was done?

ANSWER A-8:

Although NASA is in no position to determine by itself and in advance what can or should be commercialized, the Agency has a long tradition of undertaking fundamental science and technology work that has developed into commercial importance. Examples are launch vehicle technology, satellite communications technology, and recently the fields of earth remote sensing and the preparation of biological materials. Our present program and future plans encompass both areas of already recognized commercial significance and areas which, from where we stand, appear to have potential. Thus, we plan to continue exploring the preparation of materials of ultra-high purity and those of hitherto unmatched perfection of crystalline structure. For the conduct of our research in the earth sciences, we will continue to advance the science of observations of earth and its environment. In the area of communications technology, we will move on to activities that will have importance in the more distant future, such as the assembly and control of very large antenna structures, and the assembly and deployment of major spacecraft platforms for use on the geostationary orbit. In yet another vein, we expect to make major advances in developing a national capability to retrieve, replenish, repair, and retrofit spacecraft on orbit. We view it as quite possible that a space-servicing industry could grow out of that new capability.

Mr. Volkmer. Thank you very much, Mr. Beggs.

At this time, I will recognize the gentleman from Kansas for any questions he may have.

Mr. Winn. Thank you, Mr. Chairman.

I just wondered, Jim, if you had any suggested changes in the Space Act that have come to your attention or that you have run across, or would suggest, as the Administrator.

Mr. Beggs. No, sir. The only change—the act has been amended a number of times during the years and it might be worthwhile to go through it in detail and see if some of the things that were added over the years as amendments have outlived their usefulness. But, I could not think of anything specific in that regard. We could, I think, make some recommendations as to perhaps cleaning it up just a little bit.

But the basic act, the 1958 act, which I have read a number of times since I have come to Washington and before, I think, was a remarkable document. It was very foresighted. It provides ample authority to do almost anything that is reasonable within the context of our program, and it has stood, as I said, the test of time very well. It has given us the opportunity to move out in all of the areas of space science, space research, the manned activities, the applications areas and, of course, the very important area of continuing our aeronautics research and technology development.

So, we are well satisfied with it.

Mr. Winn. Do you think—and this is kind of a touchy subject—do you think there is any need in the Space Act itself to clarify the jurisdiction between NASA and the Department of Defense?

Mr. Beggs. No, I do not. That is a question that we have pondered quite a lot here in recent months as the question of militarization and the increase of the military activities in space. We have a very good working relationship with the military. We exchange views quite frequently with them. We have a coordinating board which is chaired by the Deputy Administrator and by the Under Secretary of Defense for Research and Development. It works well. We know what they are up to. They know very well what we are doing. Where cooperation has been desired on their part, we have generally cooperated with them. Where we have needed support from the military, they have given it.

So, I do not think we need either expansion or restrictions put on that relationship. I think it has worked well for NASA. We have been able to draw on the military from time to time for not only manpower but for various support activities on things that they have that are unique. They have been very forthcoming.

Mr. Winn. The Department of Energy has one Assistant Secretary in charge of Defense programs. This structure seems to resolve many of the past concerns about the role of the military in energy, and especially the atomic energy programs.

Do you think a similar structure would make sense at NASA in their organization for Defense programs?

Mr. Beggs. The DOE, of course, cooperates very closely with the Department of Defense and carries out certain research and development activities for them in the nuclear device field. We do not have a similar role with the DOD. They do, of course, use our test facilities and we do occasionally cooperate in joint R&D programs.

But we do not work directly for them in developing things for their use.

As a consequence of that, I do not see the need for a special office. I think the existing structure of NASA where the Associate Administrators and their offices work from time to time with them, works well.

Mr. WINN. Maybe I can lobby you all a little bit, you and the other former Administrators whom I deeply respect.

I would like for you, since you are all here together—you don't do that too often any more, I do not think because of the different directions that everyone has gone—if you could just figure out for the committee how we can have a fifth orbiter and the space station all going at the same time, I think all of us would appreciate it. [General laughter.]

Mr. BEGGS. I would welcome that help.

Mr. WINN. Thank you, Mr. Chairman.

Mr. VOLKMER. Thank you.

I now recognize the gentleman from Florida.

Mr. NELSON. Thank you, Mr. Chairman.

Good morning, Mr. Beggs.

Mr. BEGGS. Good morning.

Mr. NELSON. Could you elaborate and bring me up to date on the sentence on page 4:

> NASA is also in the process of privatizing the operation of expendable launch vehicles and service activities in connection with the shuttle, such as the preparation of payloads.

Bring us up to date on where we are there.

Mr. BEGGS. Well, Mr. Nelson, we have gone into the Commerce Business Daily with a request to have the industry submit proposals to take over the expendable launch vehicles and their systems. We have some interest developing that. We understand that we will get several proposals, both on the Atlas Centaur and the Delta vehicles. We may even get some proposals on other private vehicles, that is, for NASA support.

We have not yet received the response but I think it is imminent. I do not recall the date. Do we have a date? One response already? Anyway, there is a cutoff date and we will evaluate those. I expect that there will be some acceptable proposals received so that we can turn those systems over.

There will be, at that time, a question as to—undoubtedly a question—as to the transfer of Government assets which we will have to resolve. Until we see the proposals, we will not know what they propose to pay for the residual assets that we have. But I suspect that we will have to come up both to the OMB and to the committee and tell them what that response is and ask for concurrence in transferring the assets we have. We do have significant residual inventory in the case of the Delta, that is in vehicles under manufacture, and we have some inventories in the case of the Atlas, not as much. But we will have to go through that process. Then I hope they can indeed take them over and operate them.

Mr. NELSON. Assets, you are talking about the expendables?

Mr. BEGGS. Yes, sir. There is in process a substantial amount of hardware. There are some assets in the nature of test equipment and production equipment that they will have to have in order to continue the production and the launching of those vehicles.

Mr. NELSON. Why did we have these assets on hand?

Mr. BEGGS. Well because we are continuing to operate those systems. The Delta, I think, goes out to 1986. That is, we have launches booked through 1986 and we have bought a few additional vehicles in anticipation of other launches that will be required through that time period. The same thing is true of the Atlas. There are launches scheduled for those vehicles in the forthcoming 2 or 3 years.

Once they do all end, as we now see them—the launch schedule ends in 1986—we have nothing booked on them beyond that. So, if a private operator takes over, he takes them over, he will have to go out and develop a market for them.

Mr. NELSON. Did we have these expendables booked through 1986 for the same reason the Defense Department has arranged for expendables now through 1987, which was a backup to the shuttle?

Mr. BEGGS. Well, it was more a case that the particular payloads that were booked on those were designed specifically for launch on either a Delta or an Atlas. The expense of converting that payload to a launch on the shuttle was considered to be in excess of what was reasonable to fly on the shuttle. Therefore, they were just simply left on those expendables and our customers were told that after a certain date we would be unable to supply them with that capability. That after that, they would have to design their payloads to fly shuttle or, they would have to get their launch services elsewhere.

Mr. NELSON. Now, as I take it, you are talking about the inventory of assets that you would sell. Are those assets that you would not be using beyond 1986; is that correct?

Mr. BEGGS. That is correct, sir.

Mr. NELSON. Why would we have had an inventory of those assets beyond 1986 if we never intended to use them beyond 1986?

Mr. BEGGS. Well, we did intend to use them. There were a number of contingent payloads booked which have since fallen out of the schedule. In addition to that, we anticipated booking some expendable-only type payloads in that time period. So, with the expectation that they would come along, we had to provide that capability out to a certain point because we had agreed that it would be available out until that time period.

One can question the judgment we made as to the number we bought, but it was not very much in excess of what it has turned out that we will use. Indeed, we might use them all.

If I might add to that, Mr. Nelson, just this last summer, for example, the ESA folks ran into a problem in launching one of their scientific satellites. They came to us, asking if they could buy a flight on a Delta which we were able to offer them. That was indeed, I believe, very good—we were in a very good position to back them up and thereby to create a performance record that I think will be to the benefit of the shuttle, eventually, that we can supply launches on demand.

Mr. NELSON. As far as you see the way the Space Act is written, as you transition to this commercialization, you do not see any alteration that needs to be made?

Mr. **Beggs**. No, sir; I do not. As I say, we spent the last several months looking hard at that and we have had a number of discussions within the agency. We have asked our various advisory committees to advise us on whether they think additions or subtractions should be made. The advisory council under Dan Fink has written a report which has just been submitted and, except for some very minor comments he has, they too feel that the act is well written and well designed to take us through the next 25 years.

Mr. **Nelson**. And that would be so, if NASA were to become the lead agency out of this interagency group in the administration of the expendables, and so forth, that if NASA were chosen to be the lead agency, your opinion would be the same as to the Space Act?

Mr. **Beggs**. Well, my view is that the act gives ample authority to the agency to accept and to continue the record we have made in the commercialization area across the board, starting back at the beginning of the agency when we explored the commercial communications satellite field. Of course, we have come forward in due time and asked the Congress to pass a special act to create a private company, a uniquely, I guess, American approach to a commercialization activity. But, the act gave us ample authority to do the preliminary work on the communications satellites and bring it to the point that we could request that legislation.

There are a number of possibilities for commercialization in space itself now. The act has ample authority to allow us to bring that along to provide money and resources in the initiation of those activities. You have given us authority to write agreements with commercial entities to give them rides on the shuttle into space to test their apparatus, and we do have authority to go ahead and put seed money into various applications areas to bring them to the point where they can be picked up by private sector companies. So, it seems to me that we do have that authority in the current act.

Mr. **Nelson**. Thank you.

Mr. **Volkmer**. I now recognize the gentleman from California, Mr. Brown, for any questions.

Mr. **Brown**. Mr. Beggs, you have been referring here to the creation of Comsat, if I interpret your remarks correctly.

In looking at the past 25 years and the next 25 years, we seize on this opportunity to try and visualize some dramatic new initiatives that would carry us through the next 25 years with the same degree of success we have had before.

Comsat was one of those initiatives, as was the lunar landing, it powered the program and inspired it; helped to make it creative and productive.

I am at a loss to know what the circumstances were that led us to the creation of a Comsat, what the considerations underlying that were. I am sure you were close enough to it to have some views on that.

We had large corporate enterprises which were willing to undertake the space program without a Comsat initiative. The telephone company would have taken it over, I am sure.

What was it that led us to intervene in the marketplace, if I may say so, to create a special entity and give it a special responsibility to do a special job at that point? Can you recall that?

If you can apply that to the conditions of today and see if the situation would justify a similar action.

Mr. **Beggs**. Let me try, Mr. Brown. The existence of a new technology which has been developed to a point of practicality, using Government funds, which was substantially different from any business entity, private sector entity, which was in the telecommunications business at that time; we believe that by setting up a special entity separate from, but involving, the various telecommunications entities, that we would not pass that off to any special interest but that it would be, then, available to all in the industry on an equal basis and therefore provide the opportunity for any number of different companies to come into the field.

The belief at that time that the Government itself should maintain a significant degree of control over the formation and the initial development of that area of technology and for that reason, as you know, the Government provided a significant portion of the board of directors—one of the significant portions of the board of directors—and the industry was allowed to appoint a number, and then eventually the public.

The belief that a company set up for this specific purpose would pursue the technology and push the art faster than any other existing entity which had a multitude number of different interests. The single interest company was conceived, and I believe properly, to be capable of moving this technology more quickly forward into practicality.

I think all of those things have been proven true by history. Whether it could have been done in another way is, of course, a moot point that could be argued.

Mr. **Brown**. It is my recollection that AT&T actually wanted to do it, and we made the decision that the public interest would be better served by the option that we took.

Mr. **Beggs**. Yes, sir. I think that has been proven, too, that turning it over to an existing, very large entity which had a large interest already in telecommunications, would have given them not only an unfair advantage in this field over their competitors—and they do have some competitors—but also raises the question as to whether they would have pursued this technology as hard as they should have in balancing it against all the other interests they have.

Mr. **Brown**. It is rather interesting that the communications companies, the telephone companies, which originally had an equity interest, as I understand it, have more or less withdrawn from that equity interest and that the Government, which had a nominal authority in terms of appointing directors—if I am not incorrect—no longer exercises that authority.

Mr. **Beggs**. No, I think the Government still does appoint several of the directors. But, it is true that the industry has largely withdrawn. I think that was anticipated at the time, that in due time the industry would sell out their interest. I think they all profited by the interest they took.

And, I think it was perhaps not anticipated in degree, the magnitude of the competition that would enter the communication satellite business. In a short period of time we have seen, since the creation of Comsat, any number of other companies come in and compete in the communications satellite business. There are now proposals to have other private sector concerns compete with them across the board and even compete in the Intelsat area. I guess the jury is still out on whether that is going to be permitted. But, the competition has come rather more quickly than I think most anticipated.

Mr. BROWN. Well, let me just make one followup to that. Today, a number of observers—including some of your distinguished predecessors—feel that the technology at least is ripe for the creation of large new systems such as global resource inventory or environmental monitoring systems.

There is no substantial market for these except governments, generally. There is a private market but the predominant market probably still is Government, as Government is a major factor in communications.

It seems unlikely that under the present circumstances, if there is a potential market in this area, that it is going to be developed unless there is a substantial Government push to develop it.

My question is, Do you think that there is sufficient comparability between this situation and the communications situation of a generation ago to warrant a similar bold and dramatic initiative in terms of creating an entity to develop and carry forward this market, which otherwise—and for many of the same reasons that you cited for Comsat—might not otherwise be developed?

Mr. BEGGS. It is a little bit different, although there are many concerns in the business of doing aerial surveys of the Earth. There is not a comparable market established as there was in the telecommunications business when we established Comsat. The major market in the Earth resources area is in the value-added market. That is, what you do with the data. The acquisition of the data is not as important as the ability to interpret the data.

I think what eventually will be the most lucrative part of that business and the biggest market to be exploited is in taking the raw data and reducing it in various ways, and adding value so that you can find and develop the applications of the data. Whether a single entity can do that in the best way, I question. But it may be that there is an opportunity for a company to do that.

The proposal that this administration has put forward is simply to place the acquisition of the data under a single entity but not necessarily the second part of that, and that is the value-added part of it. That would still reside in a number of different companies in the private sector.

So, it is a little bit different than what you had in Comsat. The single best argument for doing it is that a private entity would be able to do two things for you. One, it presumably—I believe—could operate the system somewhat more efficiently and, two, it would have the capability of exercising what in the private sector is the most important thing we have, and that is the development of the market, the entrepreneurial activity.

Mr. BROWN. Well, we have discussed this many times and there is no point in belaboring it. Depending on your point of view, this can be either the bold new initiative that would challenge us for the next generation, or it is a utopian and visionary scheme which we are not ready for yet and therefore we should not waste any time on it.

I am trying to, in my own mind, determine which category this concept of developing new global space systems to serve mankind fits into. I see a lot of comparisons between these proposals and what we did in communications. But obviously, that view is not shared by everyone.

I have no further questions, Mr. Chairman.

Mr. VOLKMER. I thank the gentleman from California.

I now recognize the gentleman from Texas for any questions he has.

Mr. ANDREWS. I have no questions.

Mr. VOLKMER. Thank you.

Mr. Beggs, I have several questions, basically on the question of the Space Act of 1958 and whether we need any changes.

One of the members of the committee has suggested an amendment to the Space Act to direct that part of our national space policy, in the policy provisions, shall in effect seek to the maximum extent possible the fullest commercialization of those programs which have been proven by research and development.

I know that has been around since it was first proposed when we were doing the reauthorization. At that time, we had decided that we probably would have these hearings anyway and we would take the matter up at this time. So, the individual member decided not to pursue it at that time.

I notice that in your full statement you point out that changes that have been brought about in the Space Act have been done through the reauthorization process.

Would you have any objection at this time or, if you wish to give us a comment on it later, on that type of language being placed in the policy provisions?

Mr. BEGGS. Mr. Chairman, I have no strong objection to the words. I simply would reiterate what I said before when this was raised and that is, I think there is ample authority to do that in the act. We have had no problem in exercising the opportunities that have arisen in the commercial area. Indeed, I think we can proudly point to a number of cases where we have taken the initiative in doing that. But, as far as objection to the language, I have none.

Mr. VOLKMER. All right. I think what the gentleman was looking at, as we say, we are looking for another 25 years and not just the immediate future. I will agree that you have taken those initiatives and there really are no inhibitions in the present Space Act that prevent any type of commercialization. I think we have to recognize that, also.

Mr. BEGGS. Yes, sir.

Mr. VOLKMER. Then I would like to get briefly to a couple of questions on the recommendations of the advisory council which Mr. Fink testified to earlier. There are a couple of areas in here that I would like to discuss and see what you are doing or propose to do, if they are actually problems.

One is, they commented upon, in the space sciences, the fundamental need for cooperation between the National Science Foundation and NASA, and that NASA take the lead, and be the lead agency in these activities.

Can you comment on that?

Mr. BEGGS. Well, I think I generally agree with what the report states on that. We have taken the initiative to get together with Dr. Knapp since he has come to town and we are trying to work together closely to resolve that issue.

It is perhaps essential that we set up a coordinating activity with the NSF in the same way we have a coordinating activity set up with the DOD to coordinate what they do in the Earth sciences and the various activities they have gotten into in things like astronomy and other areas, which tend to overlap what we do. We have, I think, where we have had specific problems, gotten together and resolved them satisfactorily. We have never had a problem in doing that.

The question of who funds specific areas of research is sometimes one on which we get together and discuss, and in some cases we overlap. So, I think a coordinating activity is probably desirable.

Mr. VOLKMER. Do you plan to have a type of coordinating committee between NASA and NSF as far as having somebody from them and somebody from you?

Mr. BEGGS. I will have to discuss that with Dr. Knapp, which I will do.

Mr. VOLKMER. All right. Along that line I would like to go another step. The gentleman from Kansas in his earlier questions talked about the DOD. We have had a recommendation from one of our previous witnesses in these hearings about a joint management arrangement with DOD and NASA.

Have you had any discussions on that or any thought on it, or wish to pass on that at this time?

Mr. BEGGS. Well, I have some thoughts. I do not think it is necessary nor, indeed, desirable. The problems we have with DOD lie usually in the areas of accounting rather than technical. The arguments we generally get into with them relate to how they want to charge us for the services they render to us. Typically, the DOD has in recent years been moving into the direction of what they call full costing or fully burdened costing for their test facilities.

We in NASA, both by statute and by tradition and policy, have followed the practice of charging for our services on the basis of incremental costing or direct costing, however you would like to describe it or however the accountants would like to describe it. So, we do get into a number of disagreements with them as to the proper way of charging each other as we supply services to them and they supply services to us. In any given year they may be paying us net or we may be paying them net. That is our major problem with them, and that really would not be resolved in any way except sitting down in some way and getting their policy resolved. I have been trying to do that since I came to town.

But as far as the activities which we cooperate on and the various things that we do together, I think we are amply covered.

Mr. VOLKMER. The council's recommendation has to do with the STS shuttle operations and you have commented on that in your full statement where they provide for basically a separate organization within NASA with the Defense manpower, finances, and facilities.

We had testimony yesterday by some witnesses who felt that actual total separation was going too far. Do you wish to comment on that?

Mr. BEGGS. I think, from what I read of John Yardley's comments, I would agree with John. I think it is premature to think in terms of separation of the R&D from the operating capability at this time. I think there will come a time, however. But I think that is out 3 or 4 years after we have completed most of the development on this system, that we will want to consider a separation.

It is not too early, I suppose, to start thinking about how that ought to take place, whether it should take place as the report states, setting up a separate organization within NASA or whether it should be a separate organization outside of NASA, to do that operation. We have been doing some thinking along those lines but have reached no conclusions as yet.

Mr. VOLKMER. All right. I will appreciate, when you do come to the conclusions and formulate the decisions as to which way to go on it, if you do go that way, how far, et cetera, to advise the subcommittee of that.

Mr. BEGGS. Yes, sir.

Mr. VOLKMER. There has also been discussion during these committee hearings of current policy advisory committees and the structure of it, and discussion as to whether or not we need an independent advisory board to advise on space hearings, going back to what we had in the seventies when the old National Advisory Board was suspended.

Do you have any thoughts on that?

Mr. BEGGS. Well, I think the current advisory structure that exists within NASA is certainly ample for our needs. As you know, from time to time we set up ad hoc groups to advise us. The Congress, of course, has access to the Academy of Science and the Academy of Engineering which provide an independent source of views on our programs, and they are very active, of course, in advising the agency as well. The boards that are set up under the Academies' jurisdictions are independent—I can assure you they are independent—and they are not loath to go into any area in which we have programs or interests. They do provide, I think, a very good sounding board for future ideas. They have served the agency well and I think they have served the committees of the Congress well.

In addition to that as you know, Mr. Chairman, the President's Science Adviser has in his purview the opportunity, which he exercises from time to time, to overview our programs and to make recommendations to the President. So, there is a very substantial advisory structure in existence today in the Federal Government and a substantial one within NASA that, I think, serves us well. If it were not there, I would want to create it because it gives us a source of outside views.

I might say, the Advisory Council and the Advisory Committees that work within the NASA advisory structure are very independent. I think my colleagues here sitting behind me and all of the Administrators would confirm that in their experience. They are not hesitant to tell you when they think you are doing something wrong or when they think that you ought to be doing something differently. So, I am satisfied with what we have. I do not think, if you go back and review the history of the council, I do not think the Council was terribly effective in its position that it was put and I would not recommend that mechanism be recreated.

Mr. VOLKMER. Also, last week when we were hearing testimony from Mr. Donahue of the Space Science Board, he said that he would be willing to confer with the members of this committee, subcommittee and periodically on their recommendations, et cetera. I felt they have been independent.

You have no objections to any of those organizations, in other words, for our information?

Mr. BEGGS. No, indeed. That would, I think, provide a very good source of additional comment and information.

Mr. VOLKMER. At this time I will recognize the gentleman from Florida, the chairman of the full committee, if he has any questions of Mr. Beggs.

Mr. FUQUA. I have but one, Mr. Chairman.

We are glad to have you, Jim. One of the concerns, I guess, I have had over the years—and it has not been with your watch or the gentlemen's behind you, it has been the system—the fact that NASA seems to have an inability to really make some long-range plans as far as particularly in the space science area.

I am not asking you to get yourself in trouble with OMB, but it seems to be a bottleneck of NASA. People cannot come forth and commit—not commit but recommend—long-range programs beyond almost the fiscal year that we are in.

I am wondering if that inhibits or limits the ability of the agency to do some very long-range plans for 10 or 15 years. You can talk about plans but it is meaningless. They are only implemented when you put funds to them and start the long program of it.

It seems that it is part of the system, that it hampers NASA to do some real long-range planning.

Mr. BEGGS. I do have a couple of observations, Mr. Chairman. The current system of annual budgeting is very inhibiting in doing what needs to be done. Now, we have succeeded in the program, in establishing certain programs which are sort of level-of-effort programs or programs that continue from budget cycle to budget cycle. The most notable of those is the Explorer line which has, I would argue, been very successful over the years, a program of continuity that gives the scientists who work with us the assurance that there will be money in the program year after year so that they can depend on it and, if they have ideas or thoughts that they feel are important, they can bring them to us and we have an ability to incorporate them into future programs.

The rest of the program is inhibited by the annual budget system. The most inhibiting thing on any program of R&D, that is of our nature—and I guess we represent the highest technology part of that spectrum but it is true of any research—is that there ought to be an assurance of funding over a long period of time. That has been, I think, since the beginning a major problem with the NASA program. I recognize, within our system and the way money is appropriated, that there has to be an annual oversight process to make sure that the moneys, public moneys, are spent properly and that they are planned properly. But, if there was some way of making a national commitment that certain levels of funding would go on for, let us say, a decade or so, it would certainly make what you are after, I believe, and that is a rational plan tied to a rational budget, a lot more practical and possible.

I have thought a lot about that, both since I came back to Washington and before. I do not know quite how to do it. We are wrestling with that particular thought, though, right now. We have been talking to the OMB about ways that we might be able to continue programs for a significant period of time like 8 or 10 years.

There is nothing we do in the agency from a point of view of science or program activities that does not generally take 7 to 8 years in its accomplishment. What that says is that if you make a commitment you really are committing yourself for 7 or 8 years, but we just do not quite admit it to ourselves. We say, "Well, we are going to review it annually." I think it should be reviewed annually, do not misunderstand me there. I think we ought to come up and tell you in detail how we are doing and whether we have problems, what the problems are, and expose what we are doing fully. But, we are committing for long periods of time and it would be very helpful if we could find a way of assuring a level of funding for a number of our programs over a significant period of time.

Mr. **Fuqua**. I think Congress, particularly in the areas of R&D, the R&D part of NASA, the Department of Energy, NSF, and some of the others, we must take a hard look at least at the authorizations so that long-range planning can be implemented in a more sound basis.

Thank you very much, Mr. Chairman.

Mr. **Volkmer**. If the gentleman would yield, I would just like to comment, yesterday John Yardley recommended that we get into the possibility to give NASA permission for multiyear contracting and some type of authorizations beyond just the current year.

I would like to ask a couple more questions on testimony given yesterday. If you need to review it, I would appreciate your doing it and then maybe sending back your comments on it.

Yesterday, Jerome Simonoff who was testifying individually but who is with Citicorp Industrial Credit, recommended in ways to try and promote more commercialization, not only in the ELV's but also in such things as free flyers and whatever may come up in the future for materials processing, et cetera.

There are several things I would like to ask you about. It is interesting, you already have authority for liability insurance for loss of life and property. Mr. Simonoff has suggested this be expanded to include coverage of commercial ventures because he feels that the private market right now is not able and will not be able to cover many of these spacecraft payloads, et cetera.

Do you have an opinion on that, giving you the authority?

Mr. **Beggs**. We have talked to the insurance people quite a lot along these lines. Most of the brokers and underwriters that I have talked to in the last couple of years insist that there is ample coverage available.

But I will certainly go and look at that again and see whether some kind of insurance coverage would help if it were, you know, either guaranteed or backed by the authority we have to give them, third-party liability coverage.

The thing they worry about most—and I can attest to this because I used to worry about it myself when I was in the business world—is the third-party liability, the business of what happens if one of your spacecraft or one of your pieces of equipment lands in the middle of a large crowd after a launch, that is a very severe problem for them. I think that we have covered that with what we have done, or we are trying to cover it. I should say, we are trying to cover that liability issue for the industry by the authority we have in the Government.

Mr. VOLKMER. What about the issue of performance?

Mr. BEGGS. Well, that is where I have been assured that the private underwriters can provide sufficient coverage at a reasonable price. But, his comment surprised me, quite frankly, when I read it this morning, that he would suggest that that coverage is not available. We will go look at it.

Mr. VOLKMER. All right.

Mr. BEGGS. We will come back with an answer to you, Mr. Chairman.

[The information follows:]

Material requested for the record on page 40, line 957 by Chairman Volkmer during the October 26, 1983 hearing at which Mr. Beggs testified on the 1958 Space Act.

The commercial insurance industry currently has an available capacity of approximately $150-200 million for "all risks" insurance (i.e. insurance covering risks other than third party liability, such as satellite and launch replacement value, and projected revenues). This amount of capacity has adequately covered the requirements of Space Shuttle customers to date. However, with the projected growth in the value of satellites and satellite revenue, it is clear to NASA that the amount of available insurance must keep pace with this projected growth, if use of the Space Shuttle and other space commercialization activities are to continue unimpeded by an insurance capacity constraint.

Toward this end, NASA has established and is maintaining an active, ongoing dialogue with the insurance industry to stimulate the continuing growth in available insurance capacity. This has been accomplished through participation in and the hosting of insurance conferences, where the issues affecting this community are addressed and discussed. To date, space insurance has been largely treated by the insurance industry as an extension of aviation insurance. As such, space risks have had to share the insurance capacity dedicated to aviation risks and has been influenced, to some degree, by unrelated aviation claims.

We see a definite effort on the part of the insurance industry to increase the available insurance capacity to meet the projected growth in insurance requirements. This is being accomplished primarily in two ways. First, effort is being made by the current underwriters of space insurance to increase the share of their overall corporate underwriting capacity that is committed to writing space risks. Secondly, because the routine, frequent flights planned for the Space Shuttle, and because the multiple payloads flown the "cargo manifest" for a given Space Shuttle flight begin to give Space Shuttle operations the appearance of cargo airline and maritime operations, there is a growing interest on the part of non-aviation underwriters to participate in underwriting Space Shuttle related risks. Specific interest has been noted in the maritime and life insurance underwriting communities, the latter having significant available funds to invest.

In summary, at this time NASA feels that the concern noted by Mr. Simonoff is recognized and in hand. As such, it would not appear necessary to consider special Space Act legislation at this time to address that concern. However, should developments indicate a need for such NASA authority in order to continue to facilitate space commercialization, we will come back to the Congress to seek appropriate legislation.

Mr. **Volkmer**. The second part is on the recommendation that he made in regard to financing, that is assisting in the financing of these projects and then also for export purposes in order to compete with others, counter trade or offsets in export trade as a way to enhance U.S. competition and to give NASA the authority to do these things.

Mr. **Beggs**. If I can answer the last part first. The offset issue is a serious issue. There is almost nothing that you sell abroad these days where the country, the purchasing country, does not ask for, in fact even demands, that some kind of industrial offset be provided. We are seeing that more and more.

Since we compete large amounts of that business in the communication satellite business, for example, our industry is running into increasing competition from the French and the Germans, and the Japanese. Those countries do have a policy of working industrial offsets at the central government level. They have an office which is set up which can go in and work the problem of industrial offset.

This is a bigger question than just NASA, though. It is a pervasive question which, I think, spreads across all of our trade relations in the world and I think something needs to be done about it. I have written letters to Ambassador Brock, Bill Brock, about this and suggested that we ought to study it. He is studying that problem.

But, we will have to do something if we expect to remain competitive in these areas because in the most competitive areas our competitors do offer industrial offset on almost everything they do. We have to look at what we can do. You know, this country probably does more, we purchase more abroad and we sell more abroad, than any other industrial nation. We just need to get organized in order to make use of this.

With respect to the other part of your question on financing, again I read that comment. There are in existence a number of different ways in which the government can assist in financing—everything from the Eximbank for stuff that goes abroad to the Small Business Administration which makes loans and, of course, in most recent times the tax acts provide the capability of organizing limited partnerships for R&D and there are a number of them coming into existence which I hope will be enough of a mechanism to supply financing.

What I think we need to do—and we are looking at this very carefully—is to provide some seed moneys, some up-front moneys, to take the highest part of the risk off of the venture. We need, I think, to do just a little bit of what we have done officially through our history in investing money up front, which should lessen the risk for them to go out and raise private capital in any number of different ways.

Again, we will look at his comments very carefully because I am not aware that there is a serious problem in raising private capital once the idea is proven.

Mr. **Volkmer**. Thank you very much, Mr. Beggs. I have no further questions, if any member of the panel has additional questions?

Thank you very much. You have been very helpful and I wish to commend you for the work that you are doing.

Mr. **Beggs**. Thank you, Mr. Chairman.

Mr. **Volkmer**. We look forward to proceeding to work with you.

Mr. **Beggs**. I appreciate it.

Mr. **Volkmer**. Thank you.

We will now go to our panel, Dr. Fletcher, Dr. Paine, and Dr. Frosch, you may proceed. We will start with Dr. Paine, then Dr. Fletcher and Dr. Frosch.

Those that have statements, those statements will be made a part of the record and you may either review them in full or summarize if you so desire.

Welcome to all three of you and thank you very much for being here. Dr. Paine, you may begin.

STATEMENT OF DR. THOMAS O. PAINE, FORMER ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. **Paine**. Thank you very much, Mr. Chairman——

Mr. **Volkmer**. This is "old hat" to all of you. [General laughter.]

Dr. **Paine**. It is very nice to be back. These pictures on the wall certainly bring back a lot of memories of some very stirring meetings that we have had here in this room that have made a lot of space history, of course.

In looking at what I might contribute to this morning as the senior Administrator, I guess, present—not in Washington but here in the room—I thought that perhaps I could take the longer view and although I did not prepare a special statement I did bring along and with your permission, Mr. Chairman, I would submit this as my statement, a review of where I believe we are going next and should be going next in space.

Mr. **Volkmer**. We will put this immediately following your statement, your oral statement, in the record.

Dr. **Paine**. Thank you very much.

It seems to me, as I have looked at the concerns that the committee has expressed and the various testimony that has already been elicited by these hearings here, that my own review of the Space Act in the last 25 years of its application and then a look at where I think we are going for the next 25 years in space, suggests to me that the Space Act has very well stood the test of time.

Although I think some of the suggestions for additions to it are perfectly reasonable, at the same time, I do not think it needs any revision. On the general principle that, "if it ain't broke, don't fix it," I think I would come out on the side of continuing to work within it.

I think the Administrator of NASA has a lot of flexibility within the Space Act, and I think the general policies that it expresses as far as the U.S. civilian space program goes are just as good today as they were 25 years ago.

There are always improvements that can be made and it seems to me that you have just discussed one of these with Mr. Beggs. This is this question of the longer range planning. I have participated as a part of the Defense industry in the U.S. Air Force's moves toward greater economies through multiyear procurement.

They have been doing this on an experimental basis. In fact, my company was allowed to quote on a particular major program to provide the electronic warfare protection equipment for the F-15 fighter and the new B-1. In quoting this on a multiyear procurement basis versus an annual basis, we were able to offer very substantial savings.

That is now under way as a somewhat experimental program. It has been going on now for about 3 years and I think the savings are very evident. It allows a company to set up and to plan its production in a much more favorable way, to line up subcontractors on a more favorable basis; to hold feet to the fire because you have a long-term procurement and, I think, in general is an opportunity that NASA should be taking advantage of.

However, this does imply a long-range plan. Almost everything we do in space is about on an 8-year timeframe from the time that President Kennedy said, "Let us do those things behind you here," to the time that we set foot on the Moon was about 8 years. I would think that a 25-year look ahead—which is three 8-year segments—would be very sensible.

Looking at some of the specific questions that have arisen in this connection, it seems to me that what we need is not focus at the present time on a space station but rather focus on a space program. A space program within which a space station would certainly be an integral part, but a part which could, I think, have a much broader review if it is seen as a part of the basic infrastructure of space.

Infrastructure would consist of transportation in which the shuttle is the latest advance; the communication of which the TDRSS system is the latest advance, and a space operating center, a space laboratory. In fact, I would look at it as an operational center in orbit for the free world.

With this kind of planning and the requirements that it would put on space transportation and other infrastructure, I think the space station can be seen as a very important, but only one part, of the basic program.

It seems to me also that as you look at the space station, that the question of the fifth or the sixth orbiter, if you want to take the 25-year look, really is not a particularly pressing point. The real question, I think, is what about shuttle Mark II?

What about the automated, unmanned heavy-lift launch vehicle? Should the space station design, for example, be completely restricted to designs which can utilize payloads carried by the shuttle, or should you think more broadly in terms of future launch vehicles, and how does the whole NASA 25-year plan fit together or at least a 10-year plan?

I think that by looking at it in these ways we will get better designs at lower cost. I think the programs will perform better as they are annually reviewed, and I would certainly urge that this move toward more long-range planning be made.

I think too that it will be a help in the fundamental problem we have, the institutional problem which the Space Act addresses, of the interaction between Government and industry, and academia that is so basic to everything we do in space—not only in the United States but I think we can add to that our interactions with other space programs throughout the free world which also require a little more certainty as to where the United States is and where it is going, so that cooperative programs can be put together with some confidence that the United States will be there.

The other question that has been raised is the question of the commercialization of space. I had the pleasure last night of drinking champagne with a group of young people from the Orbital Sciences Corp. who were signing a contract which was being celebrated with Martin to develop an upper stage on a completely commercial venture.

We had a representative there from a New York investment banking firm which is proposing to raise $50 million and patting the young fellows on the heads saying, "If you need another 50, let us know." [General laughter.]

So, I think that the commercialization is moving very rapidly. I think it certainly should be a concern of this committee to see that everything possible is being done to facilitate this and keep this momentum going. But I think it is very impressive what is being done.

The question of whether commercialization can proceed under the current Space Act to me was completely demonstrated by the tremendous success of the communications satellite industry which has raised now literally billions of dollars on Wall Street and other nations around the world, and has created a global system in a very short period of time of the most advanced technology. It has spurred underwater cable technology; it has spurred microwave and optical fiber technology through its competition. It has brought rates down. It has provided, now, global TV. A great advance all done under the basic Space Act.

So, I think that this does give us the flexibility we need for commercialization.

But I think that commercialization would also be greatly benefited by a longer range NASA program and plan. I think the ability to lay out the type of long-range NASA technology development programs that are required to support commercialization and the infrastructure required are particularly important.

The idea that one of the greatest contributions NASA can make is in lower cost transport to shuttle is one I heartily endorse. Certainly, we need to keep moving in that direction.

The one thing that I would suggest could perhaps benefit the most, though, from longer range planning is the exploration of the solar system. I am very pleased to see the reports that have come in from the science advisory groups laying out a more economical but far more effective long-range plan to really understand the solar system, its origin, and the resources which are available to mankind in the future from this tremendously exciting new development that we see.

As we sit here, of course, our fundamental probes have left Saturn and are heading on out to Uranus and Neptune, so that we will have all of the planets save one, save Pluto in the solar system, having been explored by man before the end of the century. We need to follow this up now on the basis of the discoveries that have been made with the first exploratory probes with a far more organized and better planned long-range exploration of the planets.

I think, too, that the question of our future on the Moon needs to be reexamined as we look at the next 25 years in space. Again, the programs behind you on the wall there were in the nature of preliminary exploration programs. We have learned a great deal about the Moon. We certainly need to learn a great deal more.

But I think it is not too soon to be thinking in terms of when will we return? What should we be thinking of in terms of sis-luna transportation beyond the shuttle and the space station? What should we be thinking in terms of lunar orbital and lunar surface research bases?

I think that the question of mining on the surface of the Moon and the asteroids through the types of robotic systems that will be available by the end of the century is not too soon for this committee to be looking at, and not too soon for NASA to be putting into its long-range plans.

Now, I could go on in this vein, but I think it is covered in the material that I submitted.

So, let me just conclude, Mr. Chairman, by saying that I think that the space program of the United States is America at its very best. It is the positive side of America. All of our friends overseas take tremendous strength by pointing to the things that have been accomplished under the Space Act and the broad accomplishments of the American international orientation that we have had.

We are indeed the leaders of the free world in space, as well as here on the planet Earth, and we need to continue to thrust this good faith of America forward. We need to continue to invest in advanced science and technological advances which really form the cornerstone of America's defense, of America's economy and, I think, of the spirit of this country.

Thank you.

[The document referred to follows:]

SPACE: WHERE WE'RE GOING NEXT

(By Dennis Meredith)

Lunar mining, orbital labs, space colonies—"We have the technology," says Northrop Chairman Thomas Paine.

Thomas O. Paine is the very embodiment of the phrase "a man with his feet on the ground and his head in the clouds." The fifty-nine-year-old president of the Northrop Corporation, the Los Angeles-based aviation and electronics firm, was educated as an engineer, and that hard-nosed breed is not known for flights of fancy. Degrees from Brown and Stanford, World War II service aboard submarines and research work at General Electric make for a no-nonsense approach to technical matters.

But as director of NASA during the first seven Apollo missions, including the first moon landing, Dr. Paine has also presided over modern man's most remarkable adventure. He has witnessed firsthand how high the human spirit can soar, buoyed by the energy of the human mind.

As we met with Dr. Paine in his offices overlooking the sprawl of Los Angeles, it was clear that he is still a staunch advocate of vigorously continuing that adventure.

Mainliner: Perhaps we should begin on a more earthly plane by discussing the roles of business and government in the very important area of microelectronics, one of the major beneficiaries of the space program.

Paine: The present leadership of the United States in electronics is based heavily on strong interaction between government and industry. Early work at Bell Telephone Laboratories, followed by university and industrial R&D with the support of the Department of Defense and NASA, led the United States from the transistor into integrated circuit chips, and now to very large-scale integration. Capability has soared while costs have plummeted.

Will the effective partnership among government, university and industry that characterized America's soaring '60s continue in the '80s? There are voices in the country now calling for government to withdraw from this partnership. I believe we need the three partners working in harmony, now more than ever.

M: Aren't our private laboratories capable of such research?

P: True, the United States has as effective an industrial research base as any in the world. But in the case of Japan, our major competitor in many areas, we face a nation that is just as effective in industrial research as we are. Japan has a driving, entrepreneurial business-management force that is skilled in working with government and labor to promote the overseas-market penetration of quality Japanese products. They understand overseas markets, and emphasize high quality, new features, competitive price and product service. This mastery of business fundamentals is providing formidable challenges to some U.S. industries, which I think in the long run will benefit both countries and, indeed, the rest of the world.

M: So you don't necessarily see competition with the Japanese as bad for the country.

P: Not at all. People who complain about Japanese automobile and steel imports usually don't stop to think that there are more acres of farmland in the United States planted for the Japanese market than there is acreage planted in Japan; and Japan's airlines buy their aircraft in America.

We specialize here because of our aerospace R&D and our mechanized agricultural resources; they specialize in cameras, televisions, ships and cars because of their brain power and ability in industrial organization. They don't have mineral, energy or agricultural resources; educated, hard-working, well-organized people are their economic resource. And it's one that we, with our own work ethic and competitive free-enterprise system, can only applaud and resolve to outperform. Free trade is a cornerstone of the post-imperial world order we are working to build.

M: In In an area related to electronics—robotics—the Japanese also appear to have a considerable lead, don't they?

P: No, I wouldn't agree that the Japanese have a technological lead; the United States is very much in the forefront of this important new technology. Just look at those magnificent observations our Voyager robot spacecraft transmitted to Earth from Saturn, across a billion miles. Highly detailed studies of Saturn's rings and moons are yielding new information about the formation and history of the solar system.

We have the technology to launch robot spacecraft and control them across billions of miles of space. We design them for useful lifetimes without human intervention of more than thirty years. Clearly, we have the technology to handle increasingly complex robotic systems—to monitor their performance, to make them self-heating and to teach them to perform complicated tasks.

The question is the degree to which American industrial management will have the motivation to move forward as boldly as the Japanese, the question of incentives to take high risks in our system, with our heavy tax burden, high inflation and burdens of regulations. We have the technology; we need to stimulate more entrepreneurial, high technology, risk investments.

M: What kinds of developments do you think will make robotics an important future technology?

P: Technically, the development of advanced robots is dependent on progress in microelectronics and computer hardware and software. Miniaturized, low-cost, high-volume information processing is the key to practical robots. As we combine inexpensive solid-state television camera eyes with pattern-recognition software that allows the robot to identify what it sees, we are, indeed, heading into a robotic revolution.

Robots will relieve human beings from tedious and unhealthy activities and, at the same time, turn out lower-cost, higher-quality products.

M: With the advent of the space shuttle, do you see a blossoming of the involvement of private enterprise in space?

P: Well, I wouldn't use the term blossoming; I think it's more a continuation of rapid evolution. There are already many economically practicable applications of space, weather satellites, for example, which make possible continuous global weather monitoring. These literally have revolutionized worldwide weather observation, including global hurricane and typhoon warnings and long-range forecasting.

The greatest revolution has been in communications, where communication satellites have grown rapidly from a few experimental devices to today's burgeoning global system that now links more than a hundred nations through Intelsat satellites in geosynchronous orbits 22,400 miles above earth. Communication costs across the Atlantic and Pacific have been drastically reduced, and color television pictures are now transmitted from continent to continent on a routine basis. Commercial insurance carriers now insure about $1 billion worth of satellites in orbit; these are all nongovernment satellites that have been built and launched into space with investment funds raised on Wall Street.

Looking to the future, there is no question that today's advanced communications satellites, which are thousands of times more powerful than earlier ones, will in turn become obsolescent through continuing rapid advances in space and electronics technologies. The next revolution will see the direct broadcasting of multichannel television signals from large antennae in orbit into every home. You'll either have your own antenna or use a neighborhood antenna connected to your home by a fiberoptic TV link. This will revolutionize commercial broadcasting and today's TV networks.

M: It seems, though that many proposed space projects, such as giant orbiting solar-power stations and huge space colonies, may seem just too far-out for the businessman to take seriously.

P: Sure. Most new developments go through a period when visionary prophets appear on the scene, and they invent systems that are ahead of their time, but which in retrospect were close to the ultimate winner. You don't invest commercially though, until all of the supporting technologies are ready.

For instance, the science fiction writer Arthur C. Clarke invented geosynchronous communications satellites back in 1947. But we didn't have the necessary rockets, guidance systems or solid-state electronics that would make them possible. Clarke envisioned the Intelsat system correctly, but he saw it about twenty-five years before technology from Bell Labs and NASA was ready to support it. In the movie *2011: A Space Odyssey,* he predicted space stations and lunar research bases early in the next century; he'll be right again, I'm sure. I also concur with Princetion physics professor Gerard O'Neill, who foresees the mining and processing of raw materials on the moon and the asteroids to construct large cylindrical space colonies. I believe that these will follow the first lunar colonies, which will pioneer the robotic mining and fabrication of the lunar resources.

And I think it will eventually become possible to collect solar energy by putting in orbit giant satellite systems coated with advanced photovoltaic cells, from which clean electrical energy could be transmitted to earth via microwaves. This has been proposed by Peter Glaser of Arthur D. Little. These futuristic systems are promising, but ahead of their time with the technologies we have today. Vigorous NASA programs in the 1980s and '90s will make such systems feasible early in the next century.

M: What investment opportunities are likely to develop in the 1980's?

P: Continuing opportunities will be present to invest an advanced weather and communications satellites, and soon new ventures will be formed to invest in earth-observation satellites, so-called Landsats. Beyond these lie new business opportunities in navigation satellites. Landsats can monitor continuously the world's fields and forests, fisheries and economic activities, including changing urban patterns, pollution, crops, geological resources and everything else of interest or value around the world. Navigation satellites will move all the world's air-traffic-control systems up to orbit.

M: You have advocated a very active space program over the next decades. Could you outline it?

P: The decade of the '80s should be the decade to capitalize upon NASA's technical advances in the Skylab Space Station prototype and in the space shuttle. This decade should see men and women moving—safely, economically and routinely—from the earth's surface to low earth orbit. About a third of scheduled shuttle missions are commercial, a third military and a third for NASA research. Toward the end of the decade, we should use the shuttle to construct permanent, evolutionary space stations in orbit.

We should build three stations—one in low earth equatorial orbit, a similar one in low earth polar orbit and a smaller base in geosynchronous orbit. Each would be suited for different kinds of experiments. We should also develop in this period an upper-stage chemical rocket to provide transport between low earth and geosynchronous orbits. In the 1990s we should supplement the shuttle and upper-stage rocket with the first low-cost electric orbit transfer vehicle, which could revolutionize economical transportation to geosynchronous orbit. Space stations would include medical, agricultural and industrial laboratories for experiments in the hard vacuum of space under zero gravity, an entirely new research environment. Space stations would also test space construction techniques, and provide way stations—"Cape Kennedies in the sky"—in which workers would prepare robot spacecraft shipped in aboard space shuttles for voyages of exploration throughout the solar systems. Fuel tanks would be topped off, systems checked, antennae deployed and the spacecraft launched outward to geosynchronous orbit, the moon or beyond.

M: And by the year 2000?

P: With earth-orbital operations routine, we could emplace the first space station in orbit around the moon economically, using electric orbit transfer. The next step would be to establish the first research base on the moon's surface. I believe this could be timed for the year 2000. With that permanent base, and with advanced robot systems in operation, we could begin exploring and developing the moon's mineral resources. Lunar rocks are 40 percent oxygen, so mining these will provide oxygen for breathing, water production and spacecraft refueling.

In the first decades of the next century, lunar colonies will evolve to become increasingly self-dependent. Controlled-environment agriculture will be started under glass domes; the two-week-long lunar day and one-sixth earth gravity will lead to unique growing conditions. Two decades of genetic engineering by NASA's extraterrestrial research staff could institute quite a different form of agriculture than any we've known on earth.

M: Clearly, you see a major role for robots in space.

P: Oh yes, we'll never have large gangs of astronauts in space suits digging lunar soil with shovels and carrying it on their backs to a hopper for processing, or even operating industrial plants.

A robotic factory on the moon, using robotic technology developed on earth, will be quite feasible, particularly when we advance to self-replicating robots. This can relieve us of much concern about using up our resources here on earth.

M: How about further into the twenty-first century?

P: With the blueprints of a successful lunar colony in hand, we would be able to establish a similar colony on the planet Mars. With water available there, Mars might even be easier to settle than our moon. If you want to jump all the way out to one hundred years from now, I see no reason why America's tricentennial couldn't be celebrated by self-supporting colonies of free people working on the moon and on Mars to pioneer new societies, just as we've done here in our "new world" of North and South America.

M: So, do you believe all these developments will come because of the need for materials and energy found in space?

P: Yes, but such practical needs are really no more imperative drives than man's spiritual needs—mankind's urge to explore, to emigrate outward to settle new frontiers. Our space program is the cutting edge of terrestrial life's soaring upward from the surface of the earth.

We've initiated an entirely new era in evolution. Americans are a commercially oriented people, but we must continue to push forward in space without arguing about whether NASA is spinning off enough Teflon frying pans, calculators, defense systems, communications satellities and other immediate practical benefits.

Sure, there are many practical uses of space, more every year, but we should be exploring the cosmos anyway.

The space shuttle era and the Reagan administration started simultaneously. We are in a period of national reexamination, and it's my sincere hope that from this will emerge a new determination to resume America's vital leadership in science, technology and exploration. A revitalized space program is the quickest and most effective way to capitalize on our magnificent opportunities.

Mr. Volkmer. Thank you very much, Dr. Paine.

Dr. Fletcher?

STATEMENT OF DR. JAMES C. FLETCHER, FORMER ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. Fletcher. Thank you, Mr. Chairman, members of the subcommittee.

It is a great pleasure for me to be here after several years' absence in front of you. I must say that it is a little bit nostalgic as I look around the room. On three out of the four walls the pictures were taken during my tour, I think.

Looking back on it, I must say it was one of the more exciting periods of my life and I made—for the fun of it—a list of some of the things that happened not because we started it but happened on my watch.

We had to finish the Apollo program; the sky lab program over here was done on my watch; the Viking program was finished; the ATS-6—we do not hear very much about it because we phased out of the communications program. But the ATS-6 in which we moved to India with was on my watch.

We also started a number of first launches of programs which came to fruition during my tour as Administrator. The Pioneer 10 and 11—the 10 is leaving the solar system, as was mentioned. The Mariner Venus; the Viking program; Landsat was first launched on my watch; the Apollo-Soyus was started and finished during that period of time. Skylab was finished.

Then, of course, we made a number of new starts. The Voyager program started; the multimission spacecraft; Landsat, Seasat, GOES—it is a misprint in the statement, it should be GOES—was started; TIROS-N, OSO-8, HEAO started and stopped, and started again on my watch. Pioneer Venus, Galileo which is still underway; the space telescope and, of course, the space shuttle all happened during a 6-year period, one-quarter of the 25 years that you are talking about.

I have asked myself many times since I have been a consultant to the Administrator, to Bob Cross and now to Jim Beggs, why so many things happened during that period of time and why it has slowed down. I guess you have asked yourself the same question.

I am sure there are a lot of reasons for it, but the two ones that seem to stand out in my mind are first of all, there is a continuing sequence of budget cuts, sometimes restored but still the uncertainty of what funding you are going to be able to get over the years makes you hesitate and complicates the business of any kind of planning.

I can remember one $500 million cut that was made after an agreement, I thought, made with OMB for a level funding the very next year, "What happened?" Well, the President changed his mind. That is not a good way to run a railroad and I guess that has been mentioned before. But the starting and stopping of funding of any given program is bound to increase the cost, and it has.

Then I think the other thing that has been happening is that the space shuttle startup has been a lot more expensive than we had imagined when we started the program. I think the operational costs, actually, are too high. I am sure Jim Beggs and his people are making every effort to reduce them, but that should be a high priority because the operational cost of the shuttle that is not going to be reimbursed is going to reflect back and subtract from other programs.

On the other hand, I think that now is the time to take stock. We have been 25 years. It has been a very productive 25 years. It has really been fantastic when you think about it. But nevertheless, it is time we took a look at the next 25 years, where are we heading?

I think the NAC study on the mission of NASA was a good one. I have to say that because I participated in the time that I had available from another program that I have been involved in and certainly agree with their conclusions.

I might say that there are some gaps that I would have liked to have added had there been time, and I would like to mention them briefly.

First of all, there is a problem area, I think, in what we used to call applications. Now applications and science have been put together and I think wisely so. But we sometimes think that because the communications satellite program was such an immediate success commercially, that other applications programs can be handled the same way. But the market was quite different. There was an immediate market. The television market was there. There was no overseas live television, could not be, we did not have any cables that could carry television.

In addition, there was the telecommunications industry all ready to use the communications satellite.

We do not have any such thing as that, say, for the weather satellites and that is why years ago the Weather Bureau was set up and people take advantage of the data that comes out of the Weather Bureau daily and hourly.

The Landsat is a similar one. Landsat, I do not believe, will ever be a fully commercial venture. There are just too many users of Landsat. We looked at the possibility of a commercial user, but let me give you an example of what we found in the first go-around, in other words, the first survey of the Earth with Landsat A.

The mining and minerals companies, as well as the oil companies, were heavy users of the satellite. But they got most of the information they wanted on the first go-around. When asked whether they would support another one they said, "No, we got what we want."

The supporters of the continuing use of the satellite were mostly the agrabusiness industry. There it was important to know or forecast what the world wheat production and also grain in general would be.

I do not see how any one company can support that activity. If you look at all the multiple uses of Landsat, there probably are 10 or 12 at least. There is no way that you can get a consortium of all these different industries put together and make a commercial venture out of it.

It is what economists quite often call the social value of a program. That is, the sum of all economic benefits in whatever industry it may occur to the people that receive those benefits.

Programs with very high social value, but not immediate commercial value, I think, should be funded by the Federal Government—whether it is done by the NOAA or whether it is done by NASA, I think can be argued about, but nevertheless should be supported by the Federal Government.

Another aspect of the applications program which I think is sometimes forgotten is, many of those applications satellites, as we called them, are really scientific satellites. The scientific value often far exceeds any commercial or social value, especially in the early phases.

Seasat is a good example, although it did not last as long as it should. Probably, it was an underfunded program. But nevertheless, the Seasat started out to be an applications program in which we really were going to make estimates of storms and predict storms and the severity of storms, as well as measure the oceans' surface characteristics.

But it turns out the scientific value was much higher, and as a matter of fact the program was essentially put through as a science program.

The same could be said of the current weather satellite program. I think there is no more important thing that can be done right now in the world of science than to try to predict ahead a little farther than we have been our national and international weather. But perhaps more importantly, to forecast global climate. That is, annual changes in climate.

For example, I happen to serve on the board of an organization called the University Consortium for Atmospheric Research [UCAR] which are dealing with problems of world climate. It turns out that it is very difficult to even anticipate the effect of an El Nino on the weather in North America. A good part of that is due to the fact that we do not have a good understanding of the interface between the atmosphere and the ocean.

So you see here, this involves Seasat and Weathersat, and probably a lot of other instrumentation which we do not now have.

So, I would like to emphasize the science value of all of these so-called applications satellites.

I think one other thing I should mention, even though Dr. Paine already did so, which I think is missing from that report. That is the whole idea of NASA's vision of the future. Of all agencies in Government I think NASA is the most future oriented. They do look ahead, they and their consultants or scientists do look ahead for decades and tens of decades because we want to know where the world is going.

I think that had an impact on the American public, especially the younger generation, which you cannot put a dollar value on. I call it the uplifting of the human spirit for lack of a better word. But there are probably better ways of expressing it.

I think we had better spend a portion of our funds looking at these advanced programs, these future programs, even though we do not immediately fund them this year or next year, we ought to at least be studying them.

I do not think it hurts to get a "Golden Fleece" award once in a while. I think any agency that does not get at least one a year is not doing its job. [General laughter.]

For example, I think the following things should have a very close look and continuing study. Tom already mentioned the Lunar Basin Colony, both for scientific value and also commercial value. That needs to be continually looked at.

The space station has already been mentioned. I think there is no doubt about the fact that a space station must be done. The question is, How big should it be? When should we start it, and what should it consist of? I think that needs to be looked at in greater depth.

A planned Mars mission, I do not think, should be out of the question. I think there are ways of doing it now that are much cheaper than what we originally envisioned. I think we ought to look at that and see what it would cost. See what the new ways of doing it would be. See what we do when we get there.

But that would be a very exciting mission, I think comparable with the original landing on the Moon.

Then, last but not least, sometimes an unpopular program but I think the SETI program was a good thing for NASA to have started. SETI means search for extraterrestrial intelligence. This is one of these long shots that you say, "Oh, well, I am in the political business. I should not be looking at a 100 years from now."

But if we were able to tune in on the so-called intergalactic network, that would have the biggest impact on mankind probably in all history, including the Renaissance, the Christian era, and so on, if we could actually find intelligent life somewhere else in our galaxy. It is really difficult to image what the value of such a finding would be. We ought to continue to study it.

I do not say we should implement it right away—although I personally believe we should—the value would be much greater than the cost.

With that as kind of a vision of the future, and I would support all of the things Tom said in addition, let me just say that NASA is still alive and well in my opinion. We are at a threshold, very similar to what the President indicated in his speech last year, similar to that of a 25-year-old individual in that after years of development and preparation and accomplishment it is about to enter the most productive years of its existence.

I too share that belief and I am confident that the Nation's vision of the future will continue to be one of optimism and of achievement. It will continue to be so, in part, thanks to the inspiration, implementation, and fulfillment of our greatest dreams by this outstanding organization known as NASA.

Thank you.

[The prepared statement of Dr. Fletcher follows:]

STATEMENT OF

James C. Fletcher

Former Administrator

National Aeronautics and Space Administration

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

It is indeed a pleasure for me to appear before you today to discuss the National Aeronautics and Space Act of 1958. It has been several years since I have had the opportunity to address the Subcommittee, and it seems most appropriate that on the occasion of NASA's 25th anniversary we should review this important legislation in retrospect and prospect. I have been closely associated with NASA for almost half of its 25-year history, having served as the Administrator for the Agency from 1971 to 1977 and as a consultant to the subsequent Administrators for the past six years. NASA's technological achievements in its first quarter century have been of tremendous historical significance. I believe that the current Administrator and Deputy Administrator, along with the current leadership in Congress, are in an excellent position to set the proper course for NASA's next 25 years. These hearings provide an excellent forum to chart this new direction.

During my six years as the Agency's Administrator, a number of exciting things happened: some involved the completion of programs started earlier such as Apollo, Skylab, Viking, and ATS-6; we had a number of first launches of programs which came to fruition during, or were started on, "my watch" such as Pioneer 10 and 11, Mariner Venus, Viking, Landsat as well as Apollo-Soyuz and Skylab; we also had a number of new starts such as Voyager, Multi-Mission Spacecraft (MMS), Landsat D, Seasat, GEOS, TIROS-N, OSO-8, HEAO, Pioneer Venus, Galileo, and, of course, the Space Telescope. Indeed, in retrospect, it was a great time to the the Administrator. One tends to forget the headaches, budget squeezes, attempted cancellations (Viking, Galileo, and Space Telescope almost didn't make it!), stretchouts, etc., when the actual achievements are added up. NASA was and is an organization of which the nation can be justly proud.

In recent years the activity, at least in terms of new starts, has seemed to slump. Two factors appear to have been responsible for this apparent slump: (1) a continuing sequence of budget squeezes (not that there are many dollars which could be "squeezed" out of NASA's budget; it is just that NASA has had to pay its share in previous government spending cuts) and, (2) a very expensive Space Shuttle Program start-up. In the case of the Shuttle, the research, development, test, and evaluation costs, as originally estimated, were pretty close to the mark; however, the operational costs seem to be much greater than originally anticipated. What is needed, as has been pointed out by others, is a major effort to reduce these costs. Perhaps more importantly, the Agency needs a commitment from both the Congress and OMB to maintain an approximate level of funding over a five- to ten-year span. Without such a commitment, everything is done on an ad hoc, year-to-year basis, and producing successful new starts becomes increasingly difficult. A level of funding is not uncommon in certain agencies (NSF, NIH, NBS, etc.) where the budget is held level, or even decreased in some years but restored in later ones. With such an agreed funding level, NASA could maintain a proper balance between aeronautics, science, applications, commercialization, and exploration, an aspect which seems to have been missing in recent years. Stable funding and a balanced programmatical emphasis are essential if NASA is to continue to fulfill its long-range missions.

Perhaps this would be an appropriate time to discuss NASA's long-range missions. As you will recall, Mr. Daniel Fink, Chairman of the NASA Advisory Council (NAC), presented a copy of a report on the NAC Study of the Mission of NASA to your Subcommittee on October 18, 1983. As a participant on the Mission Task Force which conducted this study, I agree with most of the conclusions in the report. I have noticed a few gaps, however, or at least several points which need to be emphasized. One problem area is in Applications. It is important that we recognize that this area is too hard to commercialize and should be considered a service to the community, such as the Weather Service, USGS, U.S. Agricultural Service, NBS, etc., since the "social" value (i.e., the sum of all the economic benefits) is not only beneficial but sometimes essential to the economic well being of the nation. Another point to be made in this area is that frequently the science value of an application is of greater value than its operational value. As an example, Seasat started as an applications program but it was quite apparent from the start that the science community had a greater requirement for it. Also weather satellites, in addition to providing improvements in weather forecasts, are helping us understand world climate and the critical interface between the atmosphere and the ocean which determine it. It is important, scientifically, that we understand that interface. Another area which must be addressed is the Space Transportation System. It is clear for the moment that NASA must continue to develop and operate the Shuttles; however, we need to do two things: (1) we should purchase an additional orbiter and (2) NASA should develop a plan to "pass the baton," i.e., transfer responsibility for Shuttle operations to a new organization, perhaps one which might be a new branch of NASA itself. Certainly, the operational aspects of the Shuttle should be separated from future manned space activities and developmental programs. There is also a national need for a Heavy Lift Launch Vehicle (HLLV). Since this capability is required for national security, it should be sponsored by the DOD; but NASA could also plan missions around this new capability.

One aspect that I feel is missing in the NASA Mission Task Force Report is NASA's "vision of the future." NASA is perhaps the most future-oriented agency in the government. Our nation expects NASA to take the long view, to "dream big dreams," and to put some of these dreams into a format which can be implemented when timing and funding permit. Some of these visions include: (1) a lunar base and colony to conduct scientific studies and to evaluate the potentially vast resources on the Moon; (2) a space station to provide a platform which will enhance national security, stimulate commercial endeavors in space, and establish a scientific laboratory to conduct a broad range of technical studies; (3) a planned Mars mission to explore our neighboring planet to find out more about its origins so that we might, in the process, learn more about our own; and (4) the search for extraterrestrial intelligence (SETI), potentially an event which could have greater world impact than the Renaissance, the new science, and Columbus! Programs such as these are an inherent part of man's fundamental drive to push the frontiers of knowledge, understanding, and human habitation. The initial investment in these programs is relatively small; large sums of money are not generally needed until actual implementation. From a small percentage of NASA's investment, in the future, the Tsiolkowskis, Goddards, Oberths, and Von Brauns of tomorrow will be heard.

As to the Charter of NASA, I do not see a need for a change. There is enough flexibility to pursue all of the above. However some change in direction is required. By mutual consent between the Executive and Legislative Branches, and within the constraints required by the need for a balanced program, we should move forward with the next major program and, at the same time, invest a larger fraction of NASA's resources in long-range mission planning.

With these goals, NASA's next 25 years can be as exciting and probably a lot more productive than the previous 25 years. President Reagan, in his recent address to NASA at the National Air and Space Museum, said that he believes that the Agency is at a similar threshold to that of a 25-year-old individual, in that after years of development, preparation, and accomplishment, it is about to enter the most productive years of its existence. I too share in that belief, and I am confident that the nation's vision of the future will continue to be one of optimism and of achievement. It will continue to be so, in part, thanks to the inspiration, implementation, and fulfillment of our greatest dreams by this outstanding organization.

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I thank you for the opportunity to testify on this important subject.

Mr. **Volkmer**. Thank you very much, Dr. Fletcher. Dr. Frosch?

STATEMENT OF DR. ROBERT A. FROSCH, FORMER ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. **Frosch**. Thank you, Mr. Chairman.

I think it is interesting that it looks as though all of the current and former Administrators here today are in violent agreement. [General laughter.]

Interesting in light of the fact that being an Administrator is a little bit like coming in in the middle of the movie and then leaving in the middle of the movie. There is a tendency to—Jim had the best part of this—but there is a tendency to finish things you did not start and start things you do not get to finish.

But we all feel, I think, part of an important and continuing process.

Let me say that I am happy to appear before the committee—not least because I think it is now fair to say, Mr. Fuqua, that the times I came to the full committee and asked for additional funds to continue the shuttle seem to have been reasonably good judgment. We have, I think, been successful and I want to thank the committee on behalf of the agency and the accomplishments for helping to do that.

It is a pleasure to appear before you to discuss the question of the mission of NASA. It has increasingly been my feeling that this subject must be considered in a long-term context. I realize how difficult it is for the National Government and particularly for the Congress, driven as it must be by annual budgets and periodic political considerations, changes in economic situations, and the continuous flow of problems, to think about things in a very long-term context, but it is important that we try to do so.

The history of NASA and the work of other agencies and other countries has put us in a position to consider ourselves not only as inhabitants of the Earth, but as inhabitants of the solar system and of the universe in a new and operational sense.

I believe that we can best understand the mission of NASA by considering it to be the investigation of the universe, the investigation, exploration and development of means for the use of the solar system, the study of the Earth from a global and planetary point of view, and the development of the necessary technology for these purposes and its dissemination for use for other purposes here on Earth. To these space missions must be added a continuation of the long-term and fruitful mission of the Agency in the investigation and development of technology for aeronautics.

It seems clear that the investigation of the broader universe continues to be an interest and an imperative stemming from the curiosity of human beings. The past decades have seen exciting developments in understanding the structure and details of the universe, and the beginnings of a belief that we understand something of the physics of its origin.

The role of space-based astronomy is essential in continuing this line of understanding since there are certain kinds of observations that are difficult or impossible to make at the bottom of our atmospheric ocean. Thus, NASA should play, along with its counterparts in other agencies and other countries, a special role in providing tools and observations of importance to the human attempt to understand our larger universe.

The NASA role with regard to the solar system, our near and accessible neighborhood, is even more important. It has become clear from our exploratory examinations that far from being a collection of bare rocks, the stuff of the solar system is complex and contains resources of material and of energy that are fascinating in the clues they give us to its origin and nature, but also interesting because of their potential for human use.

There is no shortage of energy in the solar system; indeed, the solar energy which drives the Earth is a bare fraction of that available; it forms a vast, if dilute, resource available to us for future use. In addition, the availability of materials on the Moon, the asteroids, and the other planets, will be of considerable interest to us as will be the availability of space and the other bodies of the solar system as places in which to carry out industrial tasks which we may not care to do on our home planet.

The issue of use of the solar system must be seen as an issue of economics; can we use energy and material from outside the Earth in a way which is economic? By economic I mean that investment on a feasible scale will yield, in a reasonable time, a payback which is far larger than the investment.

A reasonable time for such a task is not necessarily the conventional 1 to 5 years of many business investments. What is required is the kind of long-term human investment vision which occurred in the 19th century in the vision of transcontinental railroads and the assuring of the navigability of major waterways, and in our time by major energy projects. The times for investment and fruition may be in decades, but the scale of the return is likely to be very large and therefore commensurate with a large investment over a period of time and well worth waiting for.

I elaborate in my statement to some degree on the coming technology which I believe is making this not a distant vision but something whose development we can begin on immediately, and this is the development of what is now principally industrial, robotics, and the beginnings of the use of what is called artificial intelligence. This makes possible some direction which changed the entire economics of many industrial processes and will, I think, certainly change the economics of space operations and move us in the direction of the possibility of the real economic use of energy and materials from elsewhere in the solar system.

It is important that this be seen as a combined enterprise of human use and machine use, rather than as an argument over whether people should do it or machines should do it. It is the proper use of machines as tools for human purposes which is important.

This is not an enterprise to be completed in the next several years, perhaps not even in the next several decades. But I believe it can and will be completed.

Further, the steps along the way will be of great importance to the development of automatic industrial systems and thus to our economic well-being in any case.

This suggests a long-range mission for NASA to develop the knowledge and the technology so that the human race can use the resources and energy of the rest of the solar system for its own purposes.

I am quite aware that this all sounds to many people like science fiction. But remember that those who talked of transcontinental railways, of instantaneous global television, of robots of any kind, and computers of any size, were also considered at first to be talking science fiction. Nothing that I have said invokes any new laws of physics or, as far as can be seen, any brandnew requirements other than further technological development and understanding. The real problem is to make such a thing happen.

The Earth is the only planet that we are sure supports life, and certainly the only one we know that can conveniently support life of our kind. It is thus especially precious to us and needs our continuing husbandry and care both in the sense of preservation and in the sense of cultivation and use. It is likely that we can eventually not only use the rest of the solar system for materials, production and energy, but as additional places to live. However, for a long time if not forever, there will be special characteristics to this planet that will be essential to us.

We need to view it as a global planetary entity and to develop an increasing and improving understanding of how it works, in what ways it is safe to alter it or not, and how its well being can be conserved for us, with us, and by us within the context of its structure, and function, and position in the solar system.

The ability to look globally from space and to consider the planet is in many ways unique to NASA and its mission, and the Agency ought to be considered as the instrumentality of the U.S. Government for a global view of the planet. This does not mean that it should undertake all aspects of this by itself but rather that it should play the leading role in carrying out such a mission.

It is clearly worth a considerable investment to understand the mechanics of the planet in the face of the possibility that there may be a number of ways in which we can destroy its support systems and capabilities without even understanding that we are doing so. A system of continuous remote sensing of environmental, agricultural, natural, and industrial events, both for the land and the 70 percent of the planets that are oceans, would seem to be a natural imperative. This is clearly a task which is both national and international in scope.

It seems clear, as has been noted by my predecessors, that there is a clear and straightforward route to the commercialization of the process of changing the data that comes from remote sensing into useful information. That is already at the beginning of being a burgeoning cottage industry which is growing in a number of ways and could be encouraged by appropriate policies that fostered and encouraged it.

It seems much more difficult to commercialize the establishment of the satellite systems necessary to collect the data, since the principal customer continues to be the U.S. Government. It can be commercialized in the sense that the Government becomes a statutory customer or a contractual customer, and that seems to be a way of establishing a commercial entity. It seems difficult, however, for any particular commercial enterprise to find a way to aggregate the very much fractionated nongovernment market in such a way that it could become a selfstanding operation.

In spite of the ideological idea that everything which is worth doing can immediately be commercialized, it seems that that is not so in this case, as it is not so in other cases.

I have hinted at the kind of technology development that will be essential to carry out the missions that I have described as being primary. The requirement is for an ability to work in and to do technological development in space, along with a continuing exploration with an eye toward utilization. The shuttle transportation system is a key beginning element in this technology development and, along with a family of orbiting systems, including a capability for a station which will allow longer-term human occupancy and experimentation, will be essential for the long-term mission accomplishment that I have suggested.

I see the technology questions as a consequence of the mission questions, and the technologies to be developed and adopted are those that are going to be required to carry out a human exploration and use of the solar system and looking back at the Earth.

I would only note, as I have stated in my statement, that we should not lose sight of the importance of the continuing mission of NASA in aeronautics which has been a success story of a mixture of Government R&D, commercial R&D, and practice and perhaps could be a model for other cases.

In summary, I have tried to suggest a long-range mission set for NASA which weds various scientific and operational tasks and requires as a natural part of it the development of important technology on the ground and in space. I think this is the way to have a long-term vision of the future which can be turned into reality.

The difficulty with planning in NASA has never been the problem of making plans. Indeed, there is always in the Agency in my experience a family of long-term plans, sometimes carried into considerable detail even for far in the future. The difficulty has been in turning those plans into reality by finding some way to have a continuity of budgetary support which makes it possible to carry out the plans.

I think the difficulty has always been that no President, no Office of Management and Budget and, really, no Congress, wishes to tie its own hands as to its future budgetary activities. We need to find some way in which there can be a reasonable continuity of planning while the President and the Congress maintain their capability to change their minds if they want to do so.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Frosch follows:]

this was read
into the record
by Frosch
he added
editorial
comment

TESTIMONY OF ROBERT A. FROSCH, VICE PRESIDENT, GENERAL MOTORS CORPORATION, BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS OF THE U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON SCIENCE AND TECHNOLOGY

WEDNESDAY, OCTOBER 26, 1983

Mr. Chairman, Members of the Subcommittee:

It is a pleasure to appear before you today to discuss the question of the mission of the National Aeronautics and Space Administration. It has increasingly been my feeling that this subject must be considered in a long-term context. I realize how difficult it is for the National Government, and particularly for the Congress, driven as it must be by annual budgets and periodic political considerations, changes in economic situations, and the continuous flow of problems, to think about things in a very long-term context, but it is important that we try to do so.

I have tried to keep my comments short and simple: to suggest missions and attitudes, not to design them.

The history of NASA, and the work of other agencies and other countries, has put us in a position to consider ourselves not only as inhabitants of the earth, but as inhabitants of the solar system and of the universe in a new and operational sense. I believe that we can best understand the mission of NASA by considering it to be the investigation of the universe, the investigation, exploration and development of means for the use of the solar system, the study of the earth from a global and planetary point of view, the development of the necessary technology for these purposes and its dissemination for use for other purposes here on earth. To these space missions must be added a continuation of the long-term and fruitful mission of the Agency in the investigation and development of technology for aeronautics.

It is easy to state the relationship to the requirements of national security by noting simply that the technology that arises from these investigations will be of use for national security purposes, and of course many technological developments of the Department of Defense and elsewhere will be of importance in this exploration and technology-generating role.

It seems clear that in the exploration and utilization of the universe and the solar system, and of the global examination of our planet, it will be important and useful that this be not only a United States endeavor, but an endeavor of the human race. The maximum of sensible international cooperation ought to be sought in carrying out this task. While this international cooperation ought to be driven by common interests and not used only as a convenient foil of other policy, it cannot be pursued independently of the nature of other aspects of cooperation between nations. In the history of NASA, its capabilities and technology and the subjects which it pursues have been useful tools for the extension of U.S. foreign policy. However, NASA has too frequently been used as a short-term tool rather than as part of a long-term thrust towards cooperation.

At the same time, it must be noted that not all international partners are equally easy to cooperate with, and this aspect of the problem must be considered before too elaborate plans which depend upon international arrangements are made. We ought to try to make such arrangements in such a way that important aspects of our plans, while pursued cooperatively, are not entirely at the mercy of the vagaries of short-term politics and economics.

I would like now to go back over several of the subjects in slightly greater detail before ending with some comments on the matter of commercialization and technology transfer.

A Mission in the Universe and Solar System

It seems clear that investigation of the broader universe continues to be an interest and an imperative stemming from the curosity of human beings. The past decades have seen exciting developments in understanding the structure and details of the universe, and the beginnings of a belief that we understand something of the physics of its origin. Indeed, the physics of the ultramicroscopic, the elementary particle materials, and the physics of the origin and large-scale structure of the universe are beginning to have a sensible set of relationships with each other. The role of space-based astronomy is essential in continuing this line of understanding, since there are certain kinds of observations that are difficult or impossible to make at the bottom of our atmospheric ocean. Thus NASA should play, along with its counterparts in other agencies and other countries, a special role in providing tools and observations of importance to the human attempt to understand our larger universe.

The NASA role with regard to the solar system, our near and accessible neighborhood, is even more important. It has become clear from our exploratory examinations that far from being a collection of bare rocks, the stuff of the solar system is complex and contains resources of material and of energy, that are fascinating in the clues they give us to its origin and nature, but also interesting because of their potential for human use.

There is no shortage of energy in the solar system; indeed the solar energy which drives the earth is a bare fraction of that available; it forms a vast, if dilute, resource available to us for future use. In addition, the availability of materials on the moon, the asteroids, and the other planets, will be of considerable interest to us, as will the availability of space and the other bodies of the solar system as places in which to carry out industrial tasks which we may not care to do on our home planet.

The issue of use of the solar system must be seen as an issue of economics: can we use energy and material from outside the earth in a way which is economic? By economic I mean that investment on a feasible scale will yield, in a reasonable time, a payback which is far larger than the investment. A reasonable time for such a task is not necessarily the conventional one-to-five years of many business investments. What is required is the kind of long-term human investment vision which occured in the 19th Century in the vision of transcontinental railroads and the assuring of the navigability of the major waterways, and in our time by major energy projects. The times for investment and fruition may be in decades, but the scale of the return is likely to be very large, and therefore commensurate with a large investment over a period of time, and well worth waiting for.

I believe the key to a successful exploitation of the solar system is the possibility of an extreme application of computer capabilities and robotics; a general direction of development which is now proceeding, in any case, for industrial reasons. In time we will be able to build robotic computer-controlled machines, powered by solar energy, that will be capable of the mining and collection of material, its beneficiation into the particular materials required for making parts, the making of the necessary parts and their assembly into another machine which duplicates the first; a self-replicating machine. By this means a biological-like machine system may be constructed which can utilize solar energy and extraterrestrial (or terrestrial) materials to construct a continuing version of itself.

A machine which is capable of essential self-replication is clearly an industrial capability of great flexibility, and can be used to produce energy, or industrial and commercial items, of importance and interest to us. It is not important whether one can go all the way to machines which replicate without human attention; it is only important to go most of the way, so that the amount of required direct human control and intervention is small, as this will be important to the economics of expansion into the solar system. While people will be essential (and many will want to be involved), their support is likely to be expensive compared to the support of flexible machines for manufacturing, as is the case on earth.

I do not consider this to be an enterprise to be completed in the next several years, perhaps not even in the next several decades, but I believe it can and will be completed. The steps along the way will be of great importance to the development of automatic industrial systems and thus to our economic well-being in any case.

This suggests a long-range mission for NASA: to develop the knowledge and the technology so that the human race can use the resources and energy of the rest of the solar system for its own purposes.

In order to undertake this task we will want to build up an important set of expanding capabilities in robot mining and industrial manufacturing processes; and we will want to understand how people can manage and control this technology both on the ground and in space. As a consequence we will need experimental stations in space convenient, at first, to the earth and thus in low orbit, but later on the moon other planets and asteroids. The shuttle and space stations can clearly play important roles in this kind of development.

In order to undertake this important mission (and perhaps self-replicating machines are only one, rather extreme, example of how to go about it) we will need to examine with great care the relationships of people and the work that they do, machines and work that they do, and the interactive and sometimes hybridized relationships between them.

I am quite aware that this all sounds like science fiction. Please remember that those who talked of transcontinental railways, of instantaneous global television, of robots of any kind, and computers of any size, were also considered at first to be talking science fiction. Nothing that I have said invokes any new laws of physics or, as far as can be seen, brand new requirements other than technological development and understanding.

Looking at the Earth

The earth is the only planet that we are sure supports life, and certainly the only one we know of that can conveniently support life of our kind. It is thus especially precious to us, and needs our continual husbandry and care both in the sense of preservation and in the sense of cultivation and use. It is likely that we can eventually not only use the rest of the solar system for materials, production and energy, but as additional places to live, suitably constructed and conditioned. However, for a long time, if not forever, there will be special characteristics to this planet that will be essential to us as human habitat, as agricultural potential, and as home. We need to view it as a global planetary entity and to develop an increasing and improving understanding of how it works, in what ways it is safe to alter it or not, and how its well being can be conserved for us and with us and by us, within the context of its structure, function and position in the solar system. The ability to look globally from space and to consider the planet as such, is in many ways unique to NASA and its mission, and the Agency ought to be considered as the instrumentality of the U.S. Government for a global view of the planet. This does not mean that it should undertake all aspects of this by itself, but rather that it should play the leading role in carrying out such a mission.

The importance of this way of looking at our planet is emphasized by a developing (but not completely accepted) view of the importance of life in forming the history and character of the surface of the earth, and in maintaining its present character. The living system can be seen as an organic system which determines the chemistry of the atmosphere, water, soil and oceans.

It is clearly worth a considerable investment to understand the mechanics of the planet in the face of the possibility that there may be a number of ways in which we can destroy its support systems and capabilities without even understanding that we are doing so. A system of continuous remote sensing of environmental, agricultural, natural and industrial events, both for the land and the 70% of the planets that are oceans, would seem to be a natural imperative. This is clearly a task which is both national and international in scope.

add editorial comment by speaker

The Required Technologies

I have hinted at the kind of technology development that will be essential to carry out the missions that I have described as being primary. The requirement is for an ability to work in and to do technological development in space, along with a continuing exploration with an eye towards utilization. The shuttle transportation system is a key beginning element in this technology development, and along with a family of orbiting systems, including a capability for a station which will allow longer-term human occupancy and experimentation, will be essential for the long-term mission accomplishment that I have suggested. The most economical mix for the task may well also include expendable launch vehicles.

add comments - skip to page 10 & summary

It is also the case that we have a great deal of exploration to do of the industrial processes that become possible in free-fall and very low vacuum. At the moment the cost of transportation is sufficient so that the economic opportunities are restricted to high-value, relatively low-mass, processes, but even the experimentation and learning will tell us what kinds of things are worth spending money on in these special physical circumstances. Further, we will get clues to industrial processes that are so valuable that it is worth doing things on earth that require considerable investment, even though the investment to do them in space might not be acceptable. I have in mind that some experimentation in zero-g may give us clues, for example, to materials that could be made with considerable difficulty in one-g but where the relatively cheap space experiment will tell us that some expensive things are worth doing on the ground.

In any case, a laboratory somewhere in the U.S. which could provide any g down to zero, and very high vacuum, should be in demand even at very high hourly rates. The mere fact that this laboratory is 120 miles above us, rather than 120 miles west of us, should not be too much of an embarrassment in its use.

It has perhaps been more serious that it is cumbersome, difficult, and delayed in time to schedule its use. This is probably more serious than its cost per minute. I would hope that the combination of the space transportation system and some form of space station systems would alleviate this difficulty and make space industrialization in this near-term sense an easier possibility.

A Mission in Aeronautics

Assistance to commercialization has been a theme that has been true of NASA's role in aeronautics, and that of the NACA before it. It was clear when it was a fledgling industry that more was needed than the research that individual aircraft makers could undertake, and it continues to be the case that the investment in science and technological development that NACA and NASA undertook has been amply repaid not only through direct taxes on the airline and aeronautical manufacturing industries, but through the way in which they have made it possible for us to tie the whole country and the world together in a transportation system, and by the fact that we sell our technology and capabilities to the world. It seems foolish to break up useful operating systems when they have been competent, are supported by all of the parties involved, are clearly economically sensible, and are well done. To do so for pseudo "economic" reasons is a triumph of empty belief over good sense.

The Competence of NASA

It is important to note that NASA has been particularly strong in its competence and ability to do things in a sensibly managed and technologically alive way. I feel more comfortable in saying this perhaps than my confreres can be, because I am so close to the present in my time at NASA that I can attribute, and do attribute, this capability and management competence to them and to all of my predecessors rather than to anything I may have done myself. This strength of the Agency suggests that it should be built upon. It is sensible to learn from and to use success.

Technology Transfer

One area in which NASA has tried to do a better job, but has not generally had the resources, nor has necessarily devised the correct means, has been the area of technology transfer. The situation has been somewhat different in aeronautics where the working together of NASA with the industry has made technology transfer to that industry fairly automatic.

In the areas of fundamental science, and of basic technology and technological principles and capabilities that grow out of the work of the Agency, it should be possible to have a more intimate connection with more of the industrial capability of the country. Resources to increase the participation of NASA contractors, scientists and technologists in industrial symposia and university-industrial consortia could lead to a livier cooperative set of circumstances in which the dissemination and use of NASA technology would be more automatic and happen to a much greater degree.

I have not tried to work out specific schemes, but I believe that such relationships could be built into the Agency's workings in a much more useful way. This is not a question of the demonstration of specific solutions to specific problems, but rather a contribution to technology which can be used by a variety of industries.

If NASA undertakes, as I believe it should, the development of advanced robotic and computer tools for operations in the solar system, a connection with the industrial developments in the same direction will be very important. Such a development could be an automatic part of a lively program of technological development for the purposes suggested. It would enable the Agency to be part of a technology development world which is increasingly central to U.S. industrial capability and could be a way in which NASA and the Department of Defense could both benefit from industrial developments and contribute in a major way to their own missions and to national industrial development.

Conclusion

In summary, I have tried to suggest a long-range mission set for NASA which weds the exploration and investigation of the universe, the solar system and the earth with an ability to utilize the solar system and the earth better for human purposes. This requires and involves as a natural part of it the development of important technology on the ground and in space, in order to contribute to accomplishing the mission. Coupled with the development of science and technology for aeronautics, this will give the Agency a long-term exploratory and useful thrust with a continuing flow of technological product which in itself is a suitable justification for the work of the Agency. Long-term visions always look like fiction, but many of them have turned out to be the most useful form of reality.

Mr. VOLKMER. Thank you very much, Dr. Frosch. We will now begin with the questions under the 5-minute rule.

Does the gentleman from Kansas have any questions?

Mr. WINN. Thank you, Mr. Chairman.

First I would say that I would not have missed this testimony for the world. I greatly admire these former Administrators that sit before us today. Down through the years I have asked them some pretty hard and some pretty pointed questions, but I respected their opinions.

I think because of their determination, along with that of the members of the committee, why, we have an extremely successful space program. I want to commend you for your part of the past history of NASA.

I would just like to ask you—and I will go right down the three in no particular order—do you think that NASA's goal of having 75 percent of the free world launches on the shuttle, is that consistent with our present national space policy?

Dr. FLETCHER. I do not know who you wanted to address this.

Mr. WINN. Go ahead, any of you.

Dr. FLETCHER. I will say that I think there is no difficulty with that goal at all. You are talking about the free world, I presume.

Mr. WINN. Right.

Dr. FLETCHER. That 75 percent of the free world's launches should be done by NASA, that is quite consistent with the Space Act in my opinion; I do not see any difficulty.

Dr. FROSCH. I would agree with that. I think it becomes a matter of competition for capability to do things and the price to do them. We have the technological capability. I think it is a reasonable thing to try to do.

Mr. WINN. Do you think we can do it on four shuttles?

Dr. **Frosch**. Well, I have been worried all along that one cannot run a trucking company with just enough trucks to carry the cargo. You have to have a capability for maintenance, for improvement, and for the possibility of an occasional problem.

It always seemed to me that four was kind of thin. That one began to have reasonable confidence about five. The argument was always whether you could "get away with" having as few as four or, on occasion the argument, maybe you could "get away" with having as few as three.

I think it is too thin. It would be sensible to have five.

Mr. **Winn**. Tom, do you have an opinion on that?

Dr. **Paine**. I would certainly agree with Bob. I think it is very thin at four. It assumes there will not be any accidents. It assumes that the present vision we have of the Department of Defense, of the commercialization of space, that the scientific is the maximum.

As I look at some of the assumptions behind this, it seems to me that we are not really looking in a very extensive way at a number of breakthroughs that might very well occur. I think in particular the President's so-called "Star Wars" approach to missile defense, for example, would undoubtedly require a substantially larger capability both in orbit and in transport to orbit than the four shuttles would probably support.

Mr. **Winn**. I wonder if the recording clerk could type that up within the next 20 minutes, and we will get it down to Dave Stockman. [General laughter.]

This sounds like a pretty simple statement but it may be a little larger and you may care to embellish your answer a little bit.

I will start with Tom. Would you agree that NASA's principal mission should be space exploration?

Dr. **Paine**. Well, I would take the position that if you had to reduce it all to one sentence, that is almost as good a sentence as any.

Certainly, the commercialization will obviously follow the exploration. I think that the various applications that we have seen come out of science in the last century would fully justify the view that a bold exploration program will lead to so many different applications.

I think, for example, if NASA were to take the position that they are going to develop robotics for our lunar mining, asteroidal mining, that the fallouts of that robotics program as NASA begins to reduce the data processing cost and size to smaller and smaller sizes; begins to take the television camera and write the software that will do the pattern recognition that will give the robots the opportunity to see, the opportunity to give them self-healing and operation at remote distances for long periods of time; allow the spacecraft we now have out there which are designed to maintain themselves for 30 years without the human hand touching them as they go out to the outer parts of the solar system; if NASA were to get into the business of just trying to really understand things we would require to develop agriculture on the Moon and on Mars and get into the genetic engineering required to develop special strains that would have a day that lasts for 2 weeks and then a night for 2 weeks in one-sixth gravity, all of these kinds of investigations on the part of NASA which you would call exploration would have many practical fallouts in the general effect of maintaining U.S. preeminence in long-range science and technology.

Mr. Winn. Well, if you developed agriculture in space, why, then you would have to figure out whether they would be eligible for the PIK program or not. [General laughter.]

Dr. Paine. I believe you are an expert on that, sir. [General laughter.]

Mr. Winn. Jim, do you have a response?

Dr. Fletcher. Well, I think that is a little bit narrow. If I were to generalize it just a bit, Mr. Winn, I think I would say that was probably a good goal in the last 25 years, but in the next 25 years I would use the words "exploration and occupation," and that fits more what Dr. Paine and even, I think, Dr. Frosch mentioned.

We really ought to go out there and do things, and make things, and live there. That should be the goal for the next 25 years.

Mr. Winn. Bob?

Dr. Frosch. I was going to use the words "exploration and use," which I think includes occupation necessarily as part of doing the job.

I would add one comment. There is one thing we have done very little of in space so far, and that is to have an opportunity for the serendipity of unplanned discovery. We have seen that kind of serendipity and discovery in exploration, but we have not seen much of it in what I would call laboratory experimentation because there has been relatively little opportunity for people to be engaged in exploratory experimentation other than detailed, planned things.

This is an important defect that one sees in academic and industrial research and engineering exploration where one is working on things and has an opportunity to find new effects because you are spending time, and effort, and work in a laboratory. We have not yet spent that kind of time and effort, and work in the space laboratories and that is going to be an important effect.

I think that would be an important effect in a sense of a predictible side effect of occupancy and exploratory and use experimentation in space, namely, we would be looking for one thing and be sure to find a number of other things that might be as or more important than what we were looking for. That takes time and occupancy.

Dr. Paine. Mr. Winn, to make one final comment on your question, my friend Marsha Freeman called to my attention a statement by Herman Oberth who was one of the great space visionaries and we might consider this as a sentence to add to the Space Act.

Mr. Oberth said many years ago, "This is the goal, to make available for life every place where life is possible. To make inhabitable all worlds as yet uninhabitable and all life purposeful."

Mr. Winn. Very good.

Well, again I want to thank you gentlemen for taking time from your busy schedules to appear before the committee again. I just want to say from a personal standpoint, stay healthy, all of you. We are going to need you again and your input for the next 25 years.

Thank you.

Mr. Volkmer. Thank you, Mr. Winn.

I will now recognize the gentleman from Florida, the chairman of the full committee, Mr. Fuqua.

Mr. Fuqua. Thank you, Mr. Chairman.

Let me echo the remarks of my colleague, Larry Winn, to all of you. You have added great vision not only to these hearings today but also in the years of dedicated service to the space program, particularly when you gentlemen served as Administrators. It is nice to see you all again.

You were here when I asked a question of Jim Beggs about the long-range planning. I asked that same question yesterday of Chris Kraft and John Yardley. I told the same story then—you were not here—we had a former Governor of Florida. After he left being Governor, he was called back to explain what he thought about government and how you could make it run more efficiently. He said, since he was not in government any more, he could tell the truth. [General laughter.]

So, I ask a somewhat similar question now, as outsiders and having had a chance to reflect and look upon NASA—I am concerned and I think probably all of you, we have talked about this over some course of time—how can we effectuate more long-range planning and possibly with multiyear authorizations? Many of the programs of NASA, as Jim Beggs said and as you well know, require some 5 to 10 years, even, for the total from conception to operation.

I would be interested in your comments. Is there anything in the act that needs changing? Is it Congress, OMB, or a combination, or none of the above, or whatever?

I would be interested, Tom, in your comments, also Jim's and Bob's.

Dr. Paine. Well, I think you have three pretty good people to ask that question because we have all been in the position of testifying before you and feeling very strongly restraints upon us.

I think that Mr. Beggs has to appear before you as the member of President Reagan's administration who has the responsibility for the space agency, but also the responsibility to reflect to you administration policy. So, he will always have certain restraints.

I think it is not a question of telling the truth as much as it is trying to balance the numbers.

Mr. Fuqua. I did not think that that had been stated before. [General laughter.]

Dr. Paine. But I do think, Mr. Fuqua, that your committee can play a very significant role. I have been delighted with the calls that you have made on NASA increasingly strongly for a long-range plan. I think that in this way this committee above all other committees that review NASA probably has the best opportunity to get such a plan and, with the other resources you have available to you, the OTA and so forth, I think that you are making a real contribution.

I think the hearings that we are now sitting in, in which you are asking questions basically about the Space Act, is a very good way to start.

A final comment. I think the most important thing to recognize about a long-range plan is, it is not a straitjacket in which you put yourself and then you have to march through it for the next 10 or

20 years. Rather, it is the long-range context within which you put your next year's budget. The only purpose of it, really, is to tell you what do you want to do for the next year.

But you will do a much better job of laying out the next year's plan if you have this in the context of where you are going in the long run and if you can use that, then, to justify things like multiyear procurement—always with the possibility of vetoing and changing your mind.

Dr. **Fletcher**. Mr. Fuqua, I do not know a mechanism for dealing with the problem. I think it is well to put forth a long-range plan. But it ought to be a plan with dollars in it and a plan that is agreed to by both the legislative branch and the executive branch. That is difficult to do.

My own feeling is, it would be a worthwhile step to meet with officials from OMB—it is OMB primarily that is involved here, not so much the rest of the White House—and say, "All right, here is what our goals are. Here is something that we ought to be doing in the next 10 years." Let us not go 25 years for the moment.

Say, "All right, here is a level of funding." Of course, there may be ups and downs, we cannot predict what the revenue is going to be and so forth. But you are a small agency and you ought to have some smoothing in those ups and downs like the NSF or the USGS, or one of the other science agencies.

To do that, I think, is very difficult because the Congress is used to doing things in hearings like we are doing now, making speeches to each other. OMB is used to sitting back in their hideout not talking to people.

I think some mechanism for an interchange and an agreement on an acceptable level of funding, plus what we are going to do approximately within that level of funding, would be a good thing to try. I do not think we have done it yet but it is worth an experiment, anyway.

Mr. **Fuqua**. Very good. Thank you.

Dr. **Frosch**. I, too, do not know a magic mechanism. The difficulty is that OMB does not want to tie its or the President's budgetary hands. So, it does not want to make a commitment.

It might, however, be useful to have at least a statement, an agreed-upon statement, of what the planned mission directions were going to be and roughly an agreement of what they would require over a period of years, but of standing present before whatever administration was in office and whatever Congress was in.

Perhaps it would be useful to establish a statement of mission. I would not think it would be sensible to try to build it into the organic act because that really is intended to go for a very long time. But a congressional—especially a congressional and administration-agreed idea of what the direction and purposes would be, certainly as an authorization which would state some idea of what was envisioned in terms of the scale of effort over a period of years might be something which at least would be referred to.

I have no feeling that this would obviate an annual discussion with considerable heat, but it might provide at least a reference point from which that discussion could begin over a period of time, and something which could be discussed each time.

Perhaps the most important thing to accomplish—and I certainly do not know how to accomplish this—is for it to become clearer than it is that this is an area in which there are important values to be preserved and things to be done, and that there was political value in the continuity of doing them. So that new administrations, as they come in, would have these questions much higher on their agenda. They may not be high in terms of the events of the moment but they might become a kind of national continuing interest.

Pressure from this committee and the Congress, if that is possible, I think could be a way of establishing that kind of general agreement that this is a long-term job of the United States, so to speak.

Mr. **Fuqua**. I appreciate the answers. If I could have the chairman's indulgence for one more comment.

You know, one of the problems that we have—and I guess it is inherent with our political system—is, of course we have administrations that change. It happens whether it be Democrats or Republicans. You have a new group at OMB and they have different ideas, are sometimes not familiar with the long-range plans.

I remember, we got into a battle a couple of years ago about aeronautical research. It was really, I think, the problem was at OMB and it was a part of the philosophy that they had of the private sector doing all of this.

Well, the reason we have had a strong aeronautical industry in this country is because of NACA and NASA. It started after World War I when the United States realized how far behind it was in aeronautical abilities.

So, these things happen and I do not know that we will ever change the system, I am not advocating that, strictly of our government. But it is one of the inherent problems that we have, regardless whoever comes in or which political party happens to be in office at that time.

But in a program such as NASA's where it is long range, we do need to factor in some more planning. I agree with, I think it was Bob Frosch that said, it is not necessarily the organic act that needs to be changed. I think it can be implemented beyond that or outside of that.

The more I read the act, the more I sometimes even compare it to the Constitution, it was well written. It has a lot of flexibility within it and I am very reluctant at any time to see changes because sometimes the change is well intended but happens to narrow the scope of what NASA can do.

So, I appreciate your being here and I appreciate the contributions that you have made over the years. As Larry said, I hope we can call on you for advice for another 25 years.

Thank you, Mr. Chairman.

Mr. **Volkmer**. Thank you.

I now recognize the gentleman from New Mexico, Mr. Lujan.

Mr. **Lujan**. Thank you, Mr. Chairman.

These have been interesting hearings that we have had. I have not been able to attend all of them but the ones I have not, I have read all the statements.

It only adds to my concern, I might say. We are all committed to the space program, to the research that can come out of it. But as I read and listen to the testimony it appears to me like we are drifting, not really knowing—well, we all know what we want. We want the exploration of space; to make that nice quotation that you gave a few minutes ago, Dr. Paine, about making space habitable for people and for the benefit of people, and those sorts of things.

But what concerns me is that we are drifting, becoming kind of a nuts-and-bolts kind of organization and not the research that I see that NASA ought to be doing.

With those comments goes what I see coming, a fight in the committee—and we have hearings—and throughout the administration on, do we build a fifth orbiter. I think that kind of points out the problem that we have, do we build a fifth orbiter or do we go for the space station? Does building that fifth Orbiter say we will continue in the operational business? Does building the space station say, that will drive the science just having it there?

I am torn between those two. I would hope that we would be able to have both of them. But I think that in the final analyzis we will be looking at the dollars and where we are going to put them.

Maybe it is not as clearcut as that, whether we build a fifth orbiter or the space station, but it may be symbolic of the way that NASA is going to go.

Would you want to get into that fight a little bit and give me some of your views? Maybe I am viewing it very simplisticly, but that is my concern.

Dr. **Fletcher**. I would like to address that because I think I probably have a different idea than most on it, Mr. Lujan.

I think NASA's eye ought to be on the future. I think it ought to be looking more at the kinds of things that Dr. Paine was addressing. They cannot avoid looking at the nuts and bolts, unfortunately because that is mainly what they do. But because they have to look at the future, I think it is more important to invest money in things like the space station, if that is what the next step is—and I think it should be—than it is to worry about the fifth orbiter.

On the other hand, I think the nation as a practical thing has got to worry about whether there are enough orbiters to carry out their missions, in particular the military missions. That is a different category of things.

But NASA itself ought to be focusing on the longer range problem which is the space station. The country as a whole has got to look more at the nuts and bolts than NASA as a part of that problem, just as they are part of commercial aircraft or any other commercial space venture. They cannot avoid participating but that should not be where their main focus is.

That is a personal judgment.

Mr. **Lujan**. It bothers me, we have one space exploration mission going and we keep sending up shuttles, and we keep repeating the McDonnell Douglas experiment and maybe some answer, some beehives or whatever. But there is not that real thrust into research.

How about you, Dr. Paine?

Dr. **Paine**. Well, I think to get a real thrust into research, and research in the broadest sense to include medical research, materials research, all of the various things which we ought to be able to explore in a zero gravity situation, hard vacuum of space, the lack of atmosphere, the ability to build very large structures, I think all of these are going to require some kind of a space operating base in order to move to that next step.

The shuttle was never really envisioned as a substitute for a space station, although it has very great capabilities for 1 week or even extend missions beyond that. Nevertheless, to really do the kind of research that Bob Frosch was talking about where you try things out and then you find this or that effect and you change the course of the research is going to require some people able to go to work everyday in their orbital laboratory and really get the opportunity to get their hands on basic research.

To me, the question of a fifth orbiter, I just do not get very excited about it. I observe that the Navy has now set up a Space Command, and I also observe that the price of the Navy buying an orbiter is just about the same as putting an obsolescent World War II battleship back in commission.

I would suggest, why not buy an orbiter and try it out? They might enjoy it. [General laughter.]

Dr. FROSCH. It seems to me that one needs the central mission of exploration and use, and research that goes with it, as the central core of the desire to do something. That a space station is a consequence of doing that.

What I expect would happen if one went for a space station and for the moment ignored the question of the orbiter, would be that there would be a number of important discoveries and new uses for the space station, and new uses and discoveries in the course of using it to carry out the attempt of the larger mission of exploration and use, and that it will turn out that the question of an orbiter is not a separate question but merely a consequence of the requirements of going ahead with the larger mission and with the space station.

It may be that that would be a next-generation orbiter, but my suspicion would be that it would be very rapidly apparent that that was a part of the job of doing the station and the mission properly.

That might stretch things out a little bit, but I think it is really an important consequence and not a separate issue.

Mr. LUJAN. In connection with the stretching out, we are told that stretching out the space station 1½ or 2 years would accommodate the fifth orbiter.

Dr. FROSCH. Well, I do not know the specific planning or the timing.

Mr. LUJAN. Out of the $8 billion that we have as the NASA budget.

Dr. FROSCH. What one needs to consider is whether the Congress and the President want to minimize annual expenditure or minimize total expenditure. There is always an assumption that somehow you can do magic and minimize the total cost of the project and also do it cheaply every year.

If you want to minimize the annual costs, then you have to realize when you stretch it out you are probably making the total program more expensive.

Mr. LUJAN. May I ask you a direct question?

Dr. FROSCH. So, you have that problem.

Mr. LUJAN. The direct question, in March or April, maybe February, I will have to take a vote in this committee. You know, we would like both, no question about it. But I assume that I am going to have to make a decision on how to vote. Whether to move ahead with the space station by the year 1991 or 1992, whatever, 10 years from now; or proceeding with the fifth orbiter in 1985.

On what side of that decision would you come?

Dr. FROSCH. I would vote for the station on two grounds. One, it is in fact the future and the key thing for what I see as the long-range mission, assuming that other aspects of the long-range mission like the exploration with unmanned spacecraft and so on were not lost in that.

But I would go for the space station on the grounds both that it was the future—and that is the important part of the NASA thing—but also with the footnote that, having done that, if we really properly carry that forward, the question of a fifth orbiter will become a secondary issue to be decided on the basis of need. It would probably turn out to be needed.

Mr. LUJAN. And maybe let the DOD build that?

Dr. FROSCH. Maybe the DOD would build it for its purposes. Or maybe the whole question of operational changes would happen in the meantime. Both because it would not forward the core mission as well and because I think in the long run it would be a losing proposition, I would not go for just the continuation of a current system without something pushing forward into the future.

Mr. LUJAN. One step, then, beyond that. I would like for you to answer that question also. Along with that, the choice between the space platform or a manned space station.

Dr. FROSCH. I think you have to do both. I think a manned station is going to require some unmanned platforms as part of it to go with it. That question is not severable in that way. I think those are going to have to be built and one is going to have to go into some manned experimentation as well.

You cannot say either people or machines. It is always going to be a combination of the two.

I would make one other comment about the fifth orbiter. I think going ahead with the space station or perhaps even if we were not to do that but were just to proceed with the national program as it is, I think the question in a few years is going to be embarrassingly, "Why did not you guys tell us you needed a fifth orbiter?"

Mr. LUJAN. How would you answer that question?

Dr. FLETCHER. I would not change anything that Bob said, I completely agree with Dr. Frosch on all the points he made about the space station or the fifth orbiter, and also about the business of an unmanned platform.

You cannot have a space station without associated, flying in formation, if you like, unmanned platforms. We already have unmanned platforms in the form of space telescopes and so forth.

So, the manned platform is what is needed next.

Dr. PAINE. I would agree.

Mr. LUJAN. One final question, and maybe I move too rapidly in that direction. But the whole question of industrialization, how do we move in that direction as quickly as possible? We have, of course, some private satellites. We have some private ELV companies. Do we make a TWA or Pan American, or Eastern, or one of the nonbankrupt ones. [General laughter.]

The operational company for the shuttle? How do we move in that direction? Maybe it is premature. Maybe I am overanxious to see that.

Am I, and if I am not, how do we move quickly into that?

Dr. **Fletcher**. Well, I will give the same answer as the Fink Committee gave this summer. I think it is premature for it to be transferred to another agency. I think we ought to start planning to do that. Maybe you can set up a separate piece of NASA to do that.

But I do think that as soon as it is practical, NASA ought to get out of the business of operating a railroad and get on to its exploration and, as we mentioned, occupation of space.

I think right now, however, that would not be a practical thing to do. I would guess it would be 2 or 3 years before we could transfer it to some other agency. But the planning should be in that direction.

Mr. **Lujan**. I was thinking in terms of perhaps having an operational budget of some kind to work the shuttle, to do all of those things, which would be kind of a standard budget. Then, for each new thing that we want to try, a one-time authorization for it.

Is that basically what you are talking about?

Dr. **Fletcher**. Well, I really could not describe the mechanism. But I do think what you mentioned, Mr. Lujan, are portions of what has to be done. You have to have a separate budget for it. You may have to draw a line down at Houston and the Kennedy Space Center, "You fellows are operational and you fellows on the other side of the line are looking at advanced programs."

Personnel has to be separate. You have to have a different culture, a different way of looking at the problem than you do in designing some of these future space missions.

Then, ultimately, maybe just spin it off as a separate entity. Right now, I think that cannot be done.

Mr. **Lujan**. Go ahead. Dr. Frosch.

Dr. **Frosch**. I was just going to comment, I think you are looking at the right problem. The problem is that operations are a continuing level of things and you have to see the funding on through.

The R&D, while it has an overall continuing level requirement, tends to come in terms of specific projects and episodes that one wants to get on with. The two have to be dealt with somewhat separately.

Otherwise you find that the fire drills in the operations will destroy the R&D side because they are always so imperative that you feed things into them. That is the difficulty.

Mr. **Lujan**. That is my concern, that that is what is happening. They tell us, "Here is $8 billion"—just to take a figure. Now, within those $8 billion you have to operate. Now, make the choice of about a fifth orbiter or a new space station, or a space exploration project that you may want, or maybe something else in research. Those choices come heavy.

We ought to say, "Yes, we are going to build a fifth orbiter. Here is the money. Yes, we are going to build a space station, here is the money," and that has absolutely nothing to do with this operational project problem or with your ceiling to accomplish all of the things that need to be accomplished.

Dr. **Frosch**. I must say, the idea of having a definite amount of money with choices inside of it is a new one to me. I do not recall that happening when I was Administrator.

What we did was fight for all the pieces quite separately. In fact, that meant that the general idea that somehow the shuttle was destroying planetary exploration, for example, really was not right because it did not matter. The question of whether we got shuttle money was somehow always separate from the question of whether we got exploration money. Things came alive or died in exploration quite independently of whether they came alive or died in shuttle development.

But operations, I think, is considerably more difficult than development in terms of having to be a separate kind of thing.

Mr. **Lujan**. Today we deal in dollars and percentages of increase for the whole agency. Maybe our whole budget process has brought us to that.

Dr. **Frosch**. Yes.

Mr. **Lujan**. But that is what I see.

We could just continue these discussions because they are most interesting, but I thank you very much for your insight.

Mr. **Volkmer**. Thank you.

I have several questions, just to continue on that. As you note, quite a few questions get into the area of something that has come upon us and NASA and generally in the country, and that is this question of commercialization now.

Dr. Paine, back when you were there, did you look at the avenue of commercialization beyond communications?

Dr. **Paine**. Well, I think from the very beginning the agency has had this problem. It gets back to Mr. Lujan's question also. When is it ready to spinoff?

I can recall the early arguments when the first weather satellites were being discussed. There was, I think, at that time quite a body of opinion within the Weather Bureau that they already knew how to predict the weather and, gee, just give them the money, they would spend it on other things. They would rather have their radars and so forth. It was very difficult for NASA to sell this, as it is always difficult to sell a new thing.

Yet, it was successfully sold, successfully spun off and I think it was quite a successful, if you like, commercialization—although the customer was another Government agency.

I think when we came to the communications satellites, we had another question. It seems to me it was typical because it was completely different from the Weather Bureau question. I think each of these is going to have to require its own special treatment in order to be successful.

We had some discussion of that earlier, as to why were those decisions made. Although they were made just before my time, I can recall a lot of discussion within the Agency about whether or not the right decision had been made.

You have to put yourself back in the context of the time. There was a very strong feeling at the time that Comsat was set up that it was not necessarily going to be successful. In fact, if everybody in

America who knew somebody in Europe called them once a month, it would not justify all those channels. It just was too much.

There was a very strong feeling that this was a pretty far-out venture, this Comsat business. [General laughter.]

In those days we did not really envision the tremendous appetite for overseas television nor did we really envision the way computers were going to be talking to each other with global data networks.

I think that the question of, might we have done it through AT&T, got a tremendous amount of review and discussion, and debate. In fact, that was the central core, would it be better to do it—and there was no question about the technical competence. In fact, the entire industry was built on the Bell Laboratory invention of the integrated circuit and the very reliable semiconductor electronics which we had available, but which would not have been possible in the vacuum tube era to put into orbit.

The final decision was that the very large investment that was at present in the microwave relay systems on land and the undersea cables, might cause AT&T management to not press forward as rapidly as possible to obsolete a number of capital investments they had already made by bringing the new technology in too rapidly, and that the public would best be served by setting up something to compete in a de novo sense.

There was a lot of discussion at that time, also, that those companies which had prospered, for example in moving into the semiconductor era, were not the vacuum tube companies which had been a little reluctant to invest in something that would obsolete their product, but rather those companies that had come in and competed from the outside against the old system. So, the railroads did not do the trucking industry, nor did the trucking industry do the railroads in so far.

It is always a good idea, I think, to set up a new institution to develop a new technology. I believe that the record of Comsat and then the further invention of Intelsat which was another very gifted piece of institutional architecture to handle the global system, has stood the test of time.

Now, the new ones that are now coming along, the Landsat question and the navigation satellites that will follow that, and all of the other questions of commercialization in space, each of these will probably have to require a separate decision. In each case one of the most critical questions will be one of timing and institutional structure.

So, those two things will be different for each case and will require very good judgment indeed.

Mr. VOLKMER. Along that line, do you want to comment, Dr. Frosch?

Dr. FROSCH. I just want to add, if I may, Mr. Chairman, that we frequently hear expressed the idea that a brandnew idea which is a good technological idea simply has to be thrown out into the market and that will test whether it is a good idea.

That is an idea that comes from people who have never tried any entrepreneurial enterprise. Ideas do not sell themselves, they need champions and they have to be worked on.

The history of technology abundantly adds stories to Tom Paine's comment. I recall reading that in the 15 years it took Alexander Graham Bell to get anybody interested in the telephone, he offered it to the Western Union Telegraph Co. which at the time made two comments. One was: It was clear that anything that could be said on the telephone could be sent in a telegram. So, it was not necessary.

The other comment was: It was also clear that nobody was going to pay $5 just to talk to their grandmother in Toledo. So, it was clearly not economical.

There was a committee that studied the global requirement for electronic computers in the early days of the first attempts to build a large machine. It concluded, the world market consisted of five machines. [General laughter.]

The difficulty was that they inquired who was already doing such computation that might want to buy one. Since there were not any, there were hardly any people doing such computation at all.

That is a mistake in looking at markets. You really have to work at it to get something started, and that has to be taken into account in the idea of commercialization.

Mr. **Volkmer**. Along those lines of commercialization, as I mentioned to Administrator Beggs earlier, we have had language proposed to be inserted into the policy provision of the Space Act that says basically to maybe accent commercialization. To seek to maximize to the extent possible the fullest commercialization of those programs which have been proven by research and development.

Now, do you have any comments on that language? I think Dr. Fletcher, in reviewing your statement, et cetera, that you would have some comment, basically that as I understand it, all technology, everything we learn, does not necessarily lend itself to commercialization.

I think Dr. Frosch has just commented on that, also. Is that correct, my interpretation?

Dr. **Fletcher**. You interpreted my remarks correctly, Mr. Chairman. With regard to changing the Space Act, I also did make a comment, I think it is a risky business to change it. It was well conceived at the beginning and probably you could add a sentence or two to emphasize the commercialization aspect.

But once you open that Space Act up for reexamination, you are going to have a lot of other questions asked. I think the most worrisome one is the relationship between NASA and the Defense Department.

I would hate to open that one up again. Let me give you an example. There are a number of things that the military would like to have done for their own purposes. By the way, the space shuttle is one that they did at the time want. They will then say, "Well, this is something that NASA ought to be doing because it is naturally one of their skills." A good example was the heavy-lift launch vehicle. That is something, in my opinion, that the Defense Department very much needs.

They will stick NASA, if you change the act, say that NASA does all launch venicles, they will stick NASA with the problem of the heavy-lift launch vehicle and will never get on with the space station or colonizing the Moon, or all these other things that NASA ought to be doing.

So, I think it is a risky business to open up that act even for the smallest sentence. Too many other people will want to make their own changes.

Mr. **Volkmer**. All right. Dr. Paine?

Dr. **Paine**. I might just comment that I think one of the things that encourages industry to make investments is a feeling that they understand the basic laws and that these are not going to be changed. So that from that standpoint alone, I think, you could make a good case that continuing the Space Act pretty much in its present form will be reassuring to potential investors.

I had to reflect as I sat here—I had not thought of it before—actually I am an investor in this Orbital Sciences Co. that is doing this new upper stage completely on speculation. I have also invested in—not very much money in these things—also in the new Air Navigation System based on satellites that Jerry O'Neill up at Princeton is starting up, a very, very speculative venture, I might add.

I am a director of ARC which has just voted to put about $500 million into new satellite communication and broadcast capability based on space systems.

I just started a small company to do some of the work on computerized analysis of satellite imagery from the Landsat system.

So, when I think about my own personal position, I am very heavily involved in the commercialization of space, and all of these things look very promising to me. So, I think we are doing very well and let us just keep on the track we are on.

Mr. **Volkmer**. Dr. Frosch, you want to make a comment?

Dr. **Frosch**. Only to add my voice to my colleague's. It was an occasional nightmare of mine while Administrator that somebody would want to rewrite the Space Act for some perfectly simple and innocent purpose, and that it would go awry and a very elegant act would somehow turn into something like some of the statutes that some of my colleagues in other agencies had to live with.

Mr. **Volkmer**. Thank you very much.

Dr. Fletcher, you have commented on the implication that may hold, as far as the DOD is concerned. As I understand, you recently headed a task force reporting to DOD a need to expand the space weapons research program; is that correct?

Dr. **Fletcher**. Yes; that is correct, Mr. Chairman.

Mr. **Volkmer**. On that—I am not going to get into particulars on that—I would like you to give consideration to a general question and how do you see the implications. That is, some of us—to get back to what Mr. Lujan said—we have budgetary constraints up here. Some of us are now seeing funds going into DOD's space program more than in our civil NASA program right now.

Do you see any implications or constraints on civil NASA programs because of increases, the "Star Wars" program, as was said, from the President?

Dr. **Fletcher**. Mr. Chairman, I do have some constraints on the business of addressing the study that we performed for the White House this summer.

But directly in answer to your question, do I see any problems arising out of the——

Mr. **Volkmer**. I am talking about just budgetary.

Dr. **Fletcher**. Yes; the military space program. I think the main thing we have to watch here is that NASA, as I mentioned, does not get stuck with some program that the military wants very badly because they believe that NASA has the expertise.

There are a number of things that are being recommended in the defensive technologies program, as we call it, that NASA could do. But I think we have to protect NASA against having to pay for it; so to speak.

If they can get NASA to do it out of DOD's budget, that is one thing. But if they get NASA to do it out of their own budget, I think that would detract from its main purpose over the next 10 or 15 years, which ought to be exploration of science and commercialization.

Mr. **Volkmer**. The other thing I would like to address is the STS operations. Do you all have any suggestions as to how we may be able to, in the future, reduce these costs? Or do you see the program as leading to reductions anyway, you know, just the learning curve and operational experience?

There have been suggestions, we have had other witnesses suggest that we would have the possibility of more commercialization if we can reduce the cost of the shuttle operations, and therefore reduce the cost of the usage for commercial purposes. That is why I was wondering.

Dr. **Fletcher**. Mr. Chairman, I very strongly think that a major effort is being made to reduce shuttle costs. But I think that even more can be done.

There is a number of items. Some of them have to do with redesign of the shuttle. So, this is a matter of investing today in order to save money tomorrow.

But others have to do with the way you organize the work force, which is a very large cost, as you know, operational cost of the shuttle. I think a lot can be done in the second area as well as the first area.

I think NASA is addressing the problem but I think even nore effort could be placed there.

Mr. **Volkmer**. Thank you. Dr. Frosch?

Dr. **Frosch**. I think it is clear that the systems you use to begin something like a shuttle are different than the most economical way of operating it once you learn how.

I think the learning process is going on. That will lead to some reductions. But I think consideration has to be given to whether there are other organizational and contractual, and so on, mechanisms that would make it a cheaper operating system. It may be necessary to separate some operational aspects of it from some of the R&D aspects of it.

But I think I am, as the others, a little bit out of date on the details. Perhaps Jim may have been involved in it a little more than I, to be able to comment on it very much.

There is no question that the cost of use is a problem in commercialization. I would say, however, that it is not only cost, it is the fact that it is not an easily available resource. It takes a long time to prepare for use of it. The waiting lines are long. So, people tend to look for other things to do than to get on that queue and worry about that kind of problem.

Mr. **Volkmer**. Another area. Dr. Frosch, in your testimony you outline a compelling scenario for the future NASA role and responsibilities to our general society. One area you have emphasized as a unique mission of NASA and the Federal Government is the monitoring, remote sensing, of the Earth.

In light of the current trend to commercialize remote-sensing systems, such as the weather satellites, what role do you feel that NASA should play in that?

Dr. **Frosch**. Well, I think NASA has to continue as the basic R&D organization in remote-sensing. It has the capability to improve the system and to find new uses.

I think unless and until some firm basis is found for operating the systems, other than NASA, it had better continue being the sponsor of the system.

My fear is that an attempt to commercialize it just on the basis of saying, "Well, the market will take care of it, let us see what happens," will drop the thing in the middle and we will find ourselves without a system.

It is too important as a system to allow that to happen. I think NASA and NOAA between them have got to make sure that the system continues in being and look for some other way to do it.

But I do not believe, as I said earlier, that there is a reasonable early prospect of commercial operation of the satellite part of the system, independent of the Government. I think the Government is the principal buyer of data at the moment and will have to be at least the guarantor for that.

I think it is entirely different with regard to the turning of data into information. That, I think, can be moved along toward market commercialization more rapidly than it has been.

Mr. **Volkmer**. Now, Dr. Fletcher, you commented in regard to shuttle operations and having a separate organizational structure within NASA, not a different agency, et cetera. The NASA Advisory Council goes even farther and recommends actually a fencing in of financing, personnel, and everything concerned with shuttle operations.

We have had testimony here that there should still continue at this time the R&D along with that. Do you wish to comment on that?

Dr. **Fletcher**. Mr. Chairman, I think probably I already did. I go along with the Fink-Solomon Study that we should have a separate organization. People should be separate; funding should be separate. Maybe even they should be located differently. I am not sure whether we could afford that.

But, yes; the R&D funding is so separate from operational funding that I think it is time we began to separate those two.

Mr. **Volkmer**. In other words, be prepared for an eventual commercialization of it, or spinoff.

Dr. **Fletcher**. Well, plan at least some other way of operating. I do not think we can move to a commercialization now. I think that is in the future. But we ought to start operating as though it could be transferred and moving NASA in that direction.

Mr. Volkmer. Dr. Frosch, let me go back and review some things that happened before and one is, back in 1980 when you appeared before this subcommittee, you indicated that the Space Act is relatively clear that when true space operations begin to dominate the scene, it will be time to consider whether an entity other than NASA should be responsible for those operations.

Have we reached the point where we should consider whether NASA or some other entity is responsible for the operation?

Dr. Frosch. I think we have reached or are reaching the point where we have to think about how to operate, as opposed to how to do the R&D.

Whether that should be a separate organizational piece of NASA or something entirely separate, I am not sure. I would say, at this point I do not see any advantage to separating it totally from NASA. One would have to construct—either put it in another department or construct another independent agency. I would say, at this point the President really does not need another independent agency to worry about.

So, it would be sensible to me now to start thinking of making it an organizational piece of NASA. I am not quite sure I understand what fencing means in this context. I presume it means a separate budget line and a separate organization. Whether the Administrator should be prohibited from ever moving things across that line is another question. Presumably, he might want to have one part of his organization hire people from the other part of his organization. That, I presume, would be allowed.

But it seems to me difficult to take a system that NASA knows so well and somehow sort of filet it out of NASA and put it elsewhere. But I think one could organizationally separate it inside the Agency.

Dr. Paine. I think I might just offer a brief comment on that point. I think that a lot of the question resolves to, where do you think the shuttle program is technically.

Certainly, if you want to reduce cost on any system you start right out with the basic engineering design of the system. The shuttle, of necessity, had to be designed since it was a pioneer effort to be a successful vehicle, and all of the things that could have been done to reduce the cost simply could not be done.

It seems to me that if you regard the shuttle as the DC-1 of space and that you are really going to get commercial when you get the DC-3, that this would argue for Bob's position that at the present time it would be much better to keep the space shuttle perhaps in a separate organization but within NASA because NASA is going to have to do a lot of work in the engineering and development to really get those costs down by some fairly substantial redesigns.

That would certainly be facilitated by having the operation within NASA.

At the same time, I think that you can do a much better job of understanding what your costs are by putting some kind of a fence around it and operating it as though it were the airline and the NASA R&D was the Boeing that was going to develop the next airliner. But having both of these very tightly integrated together so that the people that are doing the cost reduction have a very good understanding of what the real costs are. Likewise, the people that are doing the operating have the ability to communicate very smoothly and conveniently with the people that are developing the new mods that are going to get some of this cost out.

Mr. **Volkmer**. I know it is getting late, but I would like to get into one other area that the gentleman from New Mexico, Mr. Lujan, covered. That is the question that is basically facing the subcommittee—and I know you answered the space station as against the fifth orbiter.

I do not disagree with that if it is strictly one or the other. But some of us feel that if we only continue with the four orbiters and with the DOD having the primary use of those orbiters; and if commercial aspects of it continue as they are, if we do prepare for a space station that we would probably need orbiters before we ever get to that space station to do some of the things like we did there with the skylab.

In other words, our orbiter now has capability of 9 to 10 days. We do not have an orbiter goal any further than the fifth orbiter has to do with the operation of the shuttle.

Mr. **Volkmer**. So you have another engine.

Dr. **Fletcher**. Yes. That is a major issue for the country. The other problem is addressing the future. That is, what are you going to do? What is the next main thrust of NASA? That should be the space station. But really, you should have both. It is a little bit like asking the question, whom would you rather murder, one of your children or your wife? [General laughter.]

I do not like to answer that question.

Mr. **Volkmer**. Well, some of us feel that perhaps we can have the station, we are right in the study period now. Maybe prolong the studies for an additional year and put the space station back a year and still within the time frame necessary and within the budgetary constraints be able to do both.

But some of us fear too that if we do not do that fifth one now, the costs, if we decide 3 years from now or 4 years from now we are going to need that thing, you know, for that space station operation, that the costs are going to be prohibitive then because everything is going to be shut down.

Dr. **Frosch**. Well, I think several years from now when started on a shuttle, one would be building a new machine. I do not think it would be the sensible and very likely not possible thing to build another one that was exactly the same.

Mr. **Volkmer**. But then you are going into something brand new that is going to cost again because you are going right into R&D right with that. That is going to be very prohibitive. So, we have problems, as usual.

Dr. Fletcher, you make some very interesting observations about the space applications program such as this area may be too hard to commercialize, it should be a service to the community. Science value and application may be a greater value than its operational value—which I basically agree with.

Are we then looking at the applications area in the wrong light? In other words, have been trying to get NASA to push some thin air out there?

Dr. **Fletcher**. Well, I cannot answer the question, Mr. Chairman, of whether you have been looking at applications in the wrong light because I am not familiar in detail with how you have been looking at it.

I think it was the right move for NASA to move science and applications together much the same as when I came in, I pulled them apart because applications, I thought, was an important aspect of what NASA did. It did produce things like Landsat and Seasat which ought to have a follow-on.

I just think it is not possible, there are too many users of something like Landsat and also all of the Metsats—meteorological satellites—to commercialize it. Sure, you can give it to a contractor to run but his principal customer will be the Government.

I cannot imagine, for example, the Weather Bureau saying, "Let us give this to a commercial outfit and make it pay for itself." There would be a furor among all the people that read the weather reports every day. And yet, they receive value from the Weather Bureau. Just knowing what the weather is going to be probably results in savings of many tens of billions of dollars every year.

The same is true, I think, for something like Landsat although the customers are not individuals but large numbers of industrial corporations which use that data.

I am a director of a very large oil company who routinely uses Landsat data for deciding where to start looking for oil. They have a lot of other technology, too but I remember one gamble—well, I had better not say the amount, I suppose—a very large gamble on just the basis of some Landsat data that they happened to procure.

Because there are so many users of something like that and weather satellites, and I suspect sea satellites when they become more available, it is just not conceivable to me as to how one company could really make a profit, so to speak, by selling the data or the results, the imagery or whatever, from the application of satellites. That is different from the communications satellites.

Mr. **Volkmer**. All right. As we get into new areas and new applications where there is no user community, how can we get a user community? How do we build one?

Dr. **Fletcher**. Well, in my judgment, Mr. Chairman, you first have to ask yourself on any new application satellite, are there enough users so that it is in the right ball park, they would get something like the benefits that it costs you to produce the satellite or the system.

I do not think you can quantify this in detailed terms, but you can make estimates of the benefits. In fact, we did a lot of that during my term as Administrator. The benefits way outweighed the cost, at least for the initial satellites.

I think you have to make these cost tradeoffs at the start and then go ahead and implement it, get the users involved in actually designing the satellite. Mostly we do that at NASA. Then we will see where it goes from there and we find out the uses are quite different after you built the system.

Even the communications satellite is quite different. It was built for overseas television, and yet, probably the major use for it now is telephonic and data communication. So, once you built it, other people come out of the woodwork and start using it.

But you ought to have the users at least there to begin with to help you design the first satellite. I think that is true of any new applicationist venture.

Mr. VOLKMER. So, what we are seeing NASA currently doing, involving as much industry as they can on the studies on the space station needs and design is the proper way to go, then.

Dr. FLETCHER. Yes; indeed.

Mr. VOLKMER. Right from the beginning, and build it to where they can use it.

Dr. Frosch?

Dr. FROSCH. I think that is right. I think this is a kind of situation in which NASA and the Government have to regard themselves as investors on behalf of the country in exactly the same sense that our private corporations will regard themselves as investors. That is, the corporation looks for a technology which it believes has future value, profit value. It looks for customers. It tries to decide whether the customers it sees are the only customers or whether other customers would be generated if it were really on the market, and it tries to assess what the risk is.

It also has to assume that it will not always be successful. I think this is a situation in which the Government has to take that kind of an investor's view.

Mr. VOLKMER. Dr. Frosch, I am going to conclude now but I just wanted to comment very briefly, I find very intriguing your statement on page 4 on the robotics and the computer capabilities, machinery that has self-replication, and the use of biological-like machine systems in the future.

Do you wish to elaborate that at all? I know it is in your statement. I read it. I find it very intriguing. Very futuristic, let me put it that way.

Has R&D been going on in this?

Dr. FROSCH. Well, the idea is simply that we are going to have more and more robotic capability. We are moving—we, a number of corporations in the United States and elsewhere—are moving in the direction of the construction of factories which can assemble machinery, rather elaborate machinery, and construct the parts for that machinery with little or no human intervention; essentially computer-operated factories.

This is getting very close to the capability of a robot system which can manufacture the parts for and assemble robot systems like itself.

So, the idea is simply that one would get very close to a capability, if not all the way, to use solar energy to build a machinery system, a factory system, that would mine materials, beneficiate them, turn them into materials and parts, and assemble other machines just like the original factory.

So, the factory would reproduce itself. That is the meaning of the biological like statement.

I do not think this is instantaneous. I think this is going to happen or could be made to happen over the period of the next couple of decades. To some degree it is going to happen in a natural way within the industrial system because a lot of corporations are moving in that way.

I think NASA might play an important role along with industry in that technology and it could be a key to economic exploration in space. I do not think it is fanciful. I think it is a very real, coming capability.

Mr. **Volkmer**. Thank you very much.

Seeing the new GM plant that I have now in my district that is going to open December 1, it is really antiquated already, then.

Dr. **Frosch**. It probably has some robots in it.

Mr. **Volkmer**. Oh, yes: it has more, probably, than any other plant in America that I know of. But like I say, it is already out of date as far as the future is concerned.

Dr. **Frosch**. We are moving in directions where over the next 10 years, certainly, factories will be more like what I am describing than the ones being opened now.

Mr. **Volkmer**. Do any of you wish to comment on what you perceive the needs of a space station to be? I know we all agree that we need one.

Do you perceive the needs or design of a space station? Do you wish to comment on that at all? It is not necessary.

Dr. **Paine**. Let me just offer one comment, Mr. Chairman, and that is, as you have your meetings on this subject which will probably intensified over the next year or two, I would just suggest that you occasionally look at your end wall here and when NASA comes up with a proposal for a space station point there and say, "All right, that is what we did 10 years ago. Now, you are going to be talking about the next 10 years. So, what is going to be the big improvements over the skylab system?"

It seems to me that one we really need to look at is the ability to service other spacecraft in Earth's orbit. In order to do this, I think that plans which would have an astronaut with big, heavy gloves on, doing EVA, trying to make adjustments to fine electronic equipment, is not terribly practical.

I think that what we really need is to be able to do work in Earth orbit in a shirt-sleeves environment, in a drydocking kind of facility where we can take complex spacecraft and without the necessity of bringing them back to Earth do the kinds of modifications and upgrading that will allow us to keep space craft like, for example, the astronomical observatory, in orbit for 10, 20, and 30 years.

As technology on various kinds of sensors advances, put the new sensors—just like Mount Pelamar is still making fundamental discoveries although it was built in the thirties. We need that same kind of capability in orbit and we need a space station that will support that same kind of infrastructure.

Mr. **Volkmer**. Dr. Fletcher, do you wish to comment?

Dr. **Fletcher**. Well, I think a lot has been said already on the space station. My own intuitive feeling is that whatever you build, you ought to build it not like sky lab but build it in a way that it can be added to.

Tom mentioned the business of refurbishing spacecraft. But I am sure there are other things that will come along. So, whatever you do, make it so that it can be added to to increase its capability. That is one thing we did not do on Skylab, Tom, I am sorry to say.

We would have liked to have made it last longer, we just did not know how to do it. It was not designed to be added to. I would say that is the only thing I would insist on if I were building a space station, make sure it can evolve into something larger.

Mr. **Volkmer**. Dr. Frosch?

Dr. **Frosch**. I agree with the previous statements. I would only like to add that to do those things will take a great deal of attention to the question of, what are the things that the people have to do and what are the things that the machines should be made to do.

I certainly agree with the comment about the gloves, and that is partly a matter of having drydocking capabilities. Partly it is a matter of having people operate machines to do things that it is not handy for people to do.

Dr. **Paine**. Maybe I could just add one personal comment and that is, if you are going to bring it back to Earth, please, do not bring it down in my wife's home State of western Australia the next time. [General laughter.]

Dr. **Frosch**. We did our best. [General laughter.]

Mr. **Volkmer**. Thank you all three very much. I appreciate your being here, it has been very helpful. Thank you very much.

[Whereupon, at 12:40 p.m., the subcommittee adjourned, to reconvene subject to the call of the Chair.]

APPENDIX 1

ADDITIONAL MATERIAL SUBMITTED FOR THE RECORD

Charter for Hearings to Review
The 1958 Space Policy Act

October 18, 19, 25, and 26, 1983

Our space policy is embodied in the enabling legislation of the United States Space program, the National Aeronautics and Space Act of 1958. Basic tenets of this policy are:

> "Activities in space should be devoted to peaceful purposes for the benefit of all mankind."
>
> "The general welfare and security of the United States require that adequate provision be made for aeronautical and space activities" and
>
> "Such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States shall be the responsibility of and shall be directed by, the Department of Defense."

The national objectives set forth in Title I of the Space Act include:

(1) The expansion of human knowledge of phenomena in the atmosphere and space;

(2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;

(3) The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space;

(4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;

(5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the applications thereof to the conduct of peaceful activities within and outside the atmosphere;

(6) The making available to agencies directly con-

cerned with natonal defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control non-military aeronautical and space activities, of information as to discoveries which have value or significance to that agency;

(7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful applicaton of the results thereof; and

(8) The most effective utilization of the scientific and engineering resources of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment.

Although there have been amendments and extensions to this legislation, the objectives expressed in the Act remain essentially intact to this day. This, in itself, is not necessarily bad, but in light of the striking advances made in space science and particularly in space applications, it appears timely to examine the role of government, and particularly that of NASA, in space activities.

Moreover, recent concern has surfaced that NASA may be entering her second quarter century with less vision than accompanied her into her first twenty five years. Our civilian space program over the last 25 years has produced national successes and demonstrated a technological prowess which suggests that our future feats in space are limited not by our imaginations but by our ability to mobilize our national resources and capabilities. Whether NASA, as the lead civilian space agency, is positioned to meet the challenges of our space future is a critical and timely question for Congressional attention. As NASA celebrates her twenty fifth anniversary, the time seems opportune to pause and examine how the major changes in the space program and our sense of where the nation is headed in space will affect NASA's future role and mission.

The character of the civilian space program is changing significantly as a number of major trends become apparent. These include:

-- Although NASA is still the largest single civilian agency in space activities, other players have become more visible in the arena, including other U.S. government agencies, private sector organizations and foreign entities.

--The space shuttle is making the transition from development to full scale operations. A clearly defined role for NASA beyond the R&D phase remains as yet undetermined, both for the shuttle and for other space transportation systems.

-- To date, the space program could be characterized as a series of individual programs of finite durations, as ends in themselves. Our future in space will rely more on the establishment and maintenance of space facilities, that is, programs that will be means rather than ends.

-- Space commercialization has become an important force in space activities. The trend can be expected to accelerate, and will bring with it the need for new business and legal understandings and arrangements. The role of the private sector will grow in accomplishing the goals of the nation's space program.

-- The past few years have seen a growing emphasis on the military uses of space. While the civilian and military functions have remained separate, the increased emphasis on national security concerns appears to be causing some blurring of the two missions.

-- The international dimension in space activity is gaining increased significance. As other nations expand their capabilities in space, our perspective as a world player in an international arena will change, requiring an ennanced understanding and appreciation of international cooperation and competition.

Due to the significance of these trends and their influence on the shape of U.S. space policy, the Subcommittee intends to initiate a review of the 1958 space policy act. The review will begin with a series of hearings focusing on NASA's future mission and responsibilities as defined in Title I of the Space Policy Act (Title I is reprinted herein: see p. 1). The Subcommittee will attempt to determine if the policies and purposes contained in the 1958 act adequately reflect the direction and scope of NASA's future, including whether NASA's ability to keep pace with changes in the space program is in any way limited by her current charter. The Subcommittee's primary objective is to shape a space infrastructure to utilize the most productive blend of government and private resources for the Nation's future investment in space. The starting point for such a task is to define a role for NASA, both as the lead civilian space research and development agency and as a participant and partner with other agencies, private industry, academia, and foreign nations. Major issues the Subcommittee will address include:

* NASA's role in the development and operation of future space transportation systems;

* NASA's role in space science;

* NASA's role in space applications;

* NASA's role in national security;

* NASA's role in commercialization and technology transfer;

- NASA's role in an era of enhanced international cooperation and competition;
- NASA's role in space policy formulation.

The Subcommittee intends to draw upon the expertise of administration officials, former NASA administrators, industry experts, and space scientists, among others, who have not only witnessed NASA's maturity to the present day, but also share a vision for her future.

APPENDIX 2

NASA ADVISORY COUNCIL
STUDY OF THE MISSION OF NASA

Conducted by the NAC
Task Force for the Study of
the Mission of NASA

October 12, 1983

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

ttn of LB-4

October 12, 1983

Mr. James M. Beggs
Administrator
National Aeronautics and
  Space Administration
Washington, DC 20546

Dear Jim:

The NASA Advisory Council's Task Force for the Study of the Mission of NASA has completed its report, which has now been approved by the Council. I am pleased to submit it to you. In response to the charter assigned it, the Task Force examined each of the principal mission areas for which NASA has a responsibility. The report contains the results of the analyses by the Task Force and recommendations for NASA action to assist in resolving a number of important issues.

Our principal recommendation is an overall "Mission of NASA" statement that represents our view of the framework on which NASA's activities for the next 20 to 40 years may be based. That statement includes both aeronautics and space segments. While the Task Force members unanimously agreed with the elements of this mission statement, there was some disagreement as to whether the mission area of Exploration of the Solar System should be viewed as an over-arching theme to guide the forward technological thrusts of the agency for the years ahead. Some strongly endorsed this theme as a central focus for NASA's future space activity. The majority of the Task Force, however, were concerned that such a specific identification would result in the diminution of the other important missions. I believe it is appropriate that the Agency address the question of the relative merits and hazards of identifying such an over-arching theme.

Our recommendations in each mission area are contained in the report itself. In the special area of operations of the Space Transportation System (STS), we conclude that full commercialization of these operations would be premature. We recommend that a new NASA organization, with its resources "fenced" from those of the rest of the Agency, be established for management of STS operations and utilization, including market development. We also recommend that, based on the value of the STS as a national resource for national security and NASA R&D missions, launch service costs charged to STS users be based upon incremental costs rather than on full recovery of recurring costs.

The Task Force looked at NASA-DOD relations in aeronautics, space technology, and STS operations. During Council discussion of the report, it was noted that there is a DOD program in space science that may not be adequately coordinated with those of NASA and other civilian organizations. We recommend that NASA take the necessary steps to assure coordination of these programs.

We appreciate the opportunity to study these fundamental and timely issues, and hope our report will be of assistance.

Sincerely,

Dan

Daniel J. Fink, Chairman
NASA Advisory Council

Enclosures

cc:
Members, NASA Advisory Council

NASA
National Aeronautics and
Space Administration
Washington, D.C.
20546

Attn of: LB-4

October 7, 1983

Mr. Daniel J. Fink
Chairman
NASA Advisory Council
National Aeronautics and
Space Administration
Washington, DC 20546

Dear Dan:

On behalf of the members, I am pleased to submit the report of the NAC Mission of NASA Task Force for consideration of the Council. I am prepared to summarize its contents at the Council's meeting on October 11 and to respond to comments and questions.

The report was prepared by a dedicated group of Task Force members who devoted considerable time and effort to the task over the past 10 months. They each gave willingly of their time and expertise to fulfill the charge laid on us. I trust our report is responsive.

Sincerely,

George E. Solomon, Chairman
for the members of the NAC Informal Task Force for
the Mission of NASA

Members:
William A. Anders
A. Richard Baldwin
Philip E. Culbertson
Peter B. Dews
Daniel J. Fink (ex-officio)
James C. Fletcher
Richard Goody
George A. Harter
Noel W. Hinners
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NASA ADVISORY COUNCIL

STUDY OF THE MISSION OF NASA

EXECUTIVE SUMMARY

A task force of the NASA Advisory Council was authorized by the NASA Administrator in July 1982 to study the long-range missions of NASA and present recommendations for the future course and direction of the Agency over a period of the next 20 to 40 years. The Task Force membership consisted of selected members of the NASA Advisory Council, augmented by additional participants representing the requisite areas of expertise.

1. The Mission of NASA

The Task Force recommends this "Mission of NASA" that rests on current statute and policy and provides a framework for NASA's activities for the next 20 to 40 years.

> Mankind has acquired the ability to move within and beyond the confines of the surface and the atmosphere of Earth, creating apparently limitless opportunities for beneficial human activity. In this regard, NASA has a dual mission--in space and the atmosphere--portions of which are overlapping.
>
> NASA's space mission is to conduct activities on behalf of the people of the United States in collaboration with other nations, to:
>
> - explore the solar system and study its planetary processes, including, as appropriate, those governing the Earth, for the benefit of humankind
> - pursue a program of fundamental scientific research in space to expand human knowledge
> - plan and implement space technology programs and research into the use of the environment of space in order to provide for the continued advance of the national space capability and its exploitation for public and commercial purposes
> - and, to achieve these ends, create the capability for an expanded human presence in space and develop and assure the operation of launch and space vehicles.
>
> NASA's mission in aeronautics is to maintain, and augment as appropriate, an aeronautics research and technology program which contributes materially to the U.S. leadership in civil and military aviation.

The Task Force believes that it is inevitable that human habitation will eventually extend beyond the confines of the Earth in many ways and on a scale far larger than is currently envisioned. Although it may not now be productive to debate the specific nature or the timing of this most dramatic of all human ventures, it is appropriate to use such a venture as a distant goal to guide our search for an understanding of the solar system and to stimulate the further advance of humankind.

2. Key Missions Considered

In arriving at this broad statement of the Mission of NASA, the Task Force considered a wide range of specific mission areas:

- Exploration of the Solar System, Including the Planet Earth, for Human Benefit
- Fundamental Space Science
- Space Technology
- Space Applications
- STS Operations
- Aeronautics
- Human Spaceflight Research
- International Relationships.

a. Exploration of the Solar System, Including Planet Earth, for Human Benefit

NASA's mission in space science can be considered in two distinct parts: one is space science conducted to contribute directly to human welfare and national need, and the other is fundamental space science conducted to expand human knowledge. The first is currently focused on solar system exploration, including the planet Earth, while the second covers the full range of space science fields, from astronomy to space physics.

NASA's mission in the exploration of the solar system itself contains two related parts, which together provide a major objectiye for the next half century. The first involves exploration of the solar system with the eventual goal of utilizing the resources and knowledge of space for human benefit. The second brings a planetary perspective to our own planet and leads to the goal of understanding those processes involved in global surface and atmosphere change especially important to living systems.

To accomplish this long range mission, the Task Force recommends that:

- The United States, in collaboration with other interested nations, vigorously pursue a program of exploration and understanding of the solar system for ultimate human benefit

- A more aggressive pursuit of the technologies of robotics, teleoperation, and machine intelligence be undertaken to maintain a proper lead and balance in the design of NASA programs

- NASA accept a leadership role in major aspects of the study of the planet Earth, in particular in those areas which concern global changes of importance to the support of human life

- Adequate funding be provided for ground-based, laboratory, and theoretical work as well as for space systems

- NASA seek a lasting national commitment in order to achieve these goals, which will require new approaches to project procedures and budgetary policies including steady funding levels and program continuity.

b. Fundamental Space Science

In fundamental science, NASA shares a responsibility with the National Science Foundation, with the break in responsibility occurring at the construction of spacecraft and space instruments. Working relations are generally satisfactory, but policy interactions have been limited. This division of responsibility has left a gray area of ground-based observations and theoretical and laboratory work, all essential for realizing the full advantages of space missions. Problems also exist in the provision of adequate funding to maintain effectiveness in research capabilities built laboriously over decades. The Task Force sees no simple solutions to these problems, but is convinced that the effort to find solutions must continue.

The Task Force recommends that:

- Space science must remain a principal part of NASA's mission because research in space science has become a central element of scientific research in the United States and the prospects for future major advances in this field remain bright

- Adequate and stable levels of funding for ground-based, laboratory, and theoretical research, a key part of NASA's scientific program, be provided independently of the fluctuating needs for spacecraft and instrument construction

- NASA take a lead role in assuring that the activities sponsored by NASA and NSF are properly coordinated.

c. Space Technology

The Task Force considered whether NASA should support the space technology needs of other government agencies, both military and civil, and the private sector. A recent study by the Aeronautics and Space Engineering Board of the National Research Council recommended that NASA's program be redirected to the needs of the broad national space constituency, and endorsed the concept of a role in space technology analogous to NASA's traditional role in aeronautics.

The developing capability to conduct space experimentation on or with the support of the Shuttle provides NASA with a unique resource for space R&T and one that is critical to the technology needs of many space users. A space station could provide an even greater laboratory in space--a "field center"--that would be truly unique in this regard. The Task Force concurs with the ASEB in its recommendation that NASA's mission in space R&T be supportive of total national space requirements.

The Task Force recommends that:

- NASA's mission in space research and technology be supportive of total national requirements, considering future needs of the civil, military, and commercial sectors. In terms comparable to those for NASA's mission in aeronautics, NASA should have the mission in space R&T to:
  - Fund, direct, and implement space research, technology, and demonstration programs in support of its own and other civil space activities; and support DOD technology needs where the results have broad application and are not duplicative of other government-funded effort
  - Encourage and facilitate, together with other appropriate agencies, the transfer of space R&T results to and within U.S. industry
  - Manage, maintain, and operate space research, development, test, and evaluation facilities. Use of the Space Shuttle and eventually a space station as a laboratory facility in space should be exploited for development of new space technologies.
- Funding for NASA space R&T be increased selectively to permit implementing these recommendations. The following criteria are suggested for identification of technologies to be accorded high priority:

  - The technology is in the national interest and will fill a reasonably established future requirement.

  - The technology offers payoff significantly greater than that presently available at a reasonable cost and is at least comparable in payoff and cost to alternative approaches to the same end.

  - The technology program is not likely to be undertaken, on a timely basis, by others, either public or private.

  - The technology is in an area in which NASA already has a demonstrated capability, or if in a new area, is one in which NASA can readily build the capability and expertise without duplicating an equivalent capability outside.

- o Funding augmentations in high priority technologies be provided only after reasonable assurance that ongoing technology developments of little potential value are being phased down and that a base level of more basic research is being maintained across the full spectrum of disciplines to assure that new technology opportunities applicable to future missions are not missed.

d. Space Applications

There appears to be little question that NASA should perform research and technology development in major space applications areas such as telecommunications, meteorology, Earth resources, and materials processing in space. However, there is much concern about how far NASA should go to provide utility demonstration and early operation of space applications systems.

NASA's role in space applications should be compatible with the overall mission of NASA. The present assumption is that NASA's primary focus should be on space R&D with involvement in operations only if necessary. The other working assumption is that NASA's primary emphasis should be on the civil side, although support of military and other defense interests is not excluded.

The Task Force recommends that the NASA mission include the study of space and space technology for civil applications, by:

- o Continuing the identification of possible civil applications of potential value and by conducting preliminary studies of potential benefits, users, and markets. This includes taking the leadership in systematic reviews of existing and possible civil applications of space

- Conducting or supporting research and technology development on essential components and subsystems of space and ground systems for civil space applications
- Conducting, with suitable cooperative arrangements with the private or public agencies, tests, demonstrations, and experimental user operations of new types of spacecraft, spaceborne systems, and ground systems for civil space applications in cases where:
    - Potential advantages, uses, and users have been identified
    - The private sector or other agencies cannot reasonably be expected to pay the full cost.

  Administration recognition of this mission of NASA should be sought.
- Arranging for the transfer to private or public agencies, as appropriate, of useful applications systems employing space technologies, unless it is in the national interest for NASA to become the operating agency.

e. STS Operations

Realization of the maximum operational efficiency for Shuttle operations is an immediate task which requires a major amount of attention from senior NASA management. A continuation of the current STS management approach might create a serious diversion of NASA resources and attention from its more traditional roles of aeronautics and space R&D and space exploration and experimentation. The view also has been expressed that NASA is not the proper organization to achieve the operating efficiencies, levels of customer satisfaction, or degree of market development desired. Therefore, resolution of the technical and management issues involved in Shuttle operations can have a major impact on future NASA missions.

Various options for the management of STS operations were examined by the Task Force, including commercial management by an industrial organization, full operation by DOD, creation of a new Federal agency for Shuttle operations management, establishment of a quasi-government corporation, creation of a new organization within NASA, and continuation of the present management arrangements in NASA.

The study group concluded that the present small size of the Shuttle fleet, its lack of maturity and high costs of operation, and the lack of DOD interest in assuming full operating responsibility, all militate against shifting Shuttle operations outside of NASA in the near future. The potential for future diversion of management attention and resources from the STS to other NASA programs suggests the advisability of further segregating the Shuttle operating management organization from the rest of the NASA organization, at least as an evolutionary, timely step.

The Task Force recommends that:

- A new NASA organization be created at the appropriate time within NASA to focus on Shuttle operations and utilization, including marketing activities and sustaining engineering support. This organization, which should be headed by a Deputy Administrator, should have fenced manpower, finances, and facilities

- The Shuttle Operations organization continue to enhance customer services and market development activities through the application of resources both internal and external to NASA as appropriate. Consideration should be given to contracting out the market development activities

- The Deputy Administrator for Shuttle Operations be charged with proposing the evolutionary steps for future management of Shuttle operations

- The Shuttle operations organization not undertake future STS development activities, such as a follow-on Shuttle or new launch capability. It should, however, help define future requirements for such major improvements

- The value of the STS as a national resource due to its unique capabilities to provide for manned spaceflight, defense missions, space science support, and research and technology development in the space environment, as well as its special capabilities for satellite retrieval and spacecraft servicing, be recognized. The total costs associated with this national resource value should not be charged to the Shuttle's launch service users

- As markets for the STS develop, NASA consider shifting pricing of Shuttle services towards an incremental (i.e., institutional) cost basis. This is the usual practice in NASA research facilities and, given the national resource character of the Shuttle for civil and military Government programs, is more appropriate than pricing on the basis of total recovery of recurring costs (industrial funding).

f. Aeronautics

When the Task Force was established, the issue of NASA's mission in aeronautics was thought to be one that would require a great deal of attention as a result of questions raised in recent years regarding the role of the Federal government vis-a-vis that of the private sector. However, a broad policy statement on the Federal mission in aeronautical R&T has been issued by the Office of Science and Technology Policy which resolved most of the issues. The Task Force addressed two derivative issues: demonstration of technology for civil aviation, and effective relations with the DOD.

The Task Force recommends that:

- NASA's mission in aeronautics, subject to specific approval, include support to the industry in civil aviation technology demonstration programs provided that they are in the national interest, the industry cannot effectively conduct the programs without that support, and the support fits naturally within NASA's capabilities
- NASA continue to assist, communicate with, and cooperate with all branches of the DOD in all matters relating to aeronautics. The first priority should be in basic aeronautics research and technologies, and should include providing access to and utilization of both human resources and laboratories and other physical test facilities as appropriate. The second priority should be in mission-oriented systems work, as requested or when special expertise or facilities are available.

g. Human Spaceflight Research

While the effects of spaceflight have proved to be manageable in flights of the durations experienced up to now, there are additional concerns when prolonged duration spaceflight, as in permanent space stations or eventually in interplanetary flight, is considered. Five areas which require intensive research include: prolonged exposure to zero gravity; provision of oxygen, food, and water; provision of an adequate social and organizational environment; exposure to ionizing radiation; and extra-vehicular activities.

The Task Force believes that it is inevitable that people will seek to explore the solar system, not only by remote sensing or even by automated acquisition of samples, but by being there, and thus ultimately extend the domain of human life beyond the confines of the Earth. The requirement for mission durations ranging from months to years is implicit. Given the significance of the issues and the lengthy interactive R&D process required, the Task Force recommends that:

NASA give high priority to the continuing program needed for the development of the capability to keep people healthy, effective, and well motivated over the long periods required for manned exploration of the solar system. The development of effective countermeasures for the disturbances associated with zero gravity requires research extending over many years, and must be addressed now to avoid later constraints on manned exploration missions.

h. International Relationships

Bearing in mind that one of the basic goals of the National Space Policy is to promote international cooperative activities in the national interest, the Task Force examined the international aspects of NASA's roles and missions. NASA's international role is very important to the maintenance of the image of the United States as the technological leader of the free world. There is need for more binding commitments in our cooperative activities in space ventures with other nations. Further, the U.S. policy on technology transfer was observed to be counter-productive because it limits other nations in their ability to procure U.S. space products rather than develop such products domestically.

The Task Force recommends that:

- NASA take the steps necessary to ensure greater awareness within the U.S. government of its value and that of its aerospace programs as an instrument of U.S. foreign policy
- Cooperative agreements between NASA and foreign or international agencies be developed and maintained consistent with long-term foreign policy objectives as well as with scientific and technological objectives to achieve a greater degree of constancy and stability.

NASA ADVISORY COUNCIL

STUDY OF THE MISSION OF NASA

A. INTRODUCTION

A study of the Mission of NASA, to be conducted by a task force of the NASA Advisory Council, was proposed by the Council in its March 1982 meeting and approved by the NASA Administrator on July 2, 1982. This study was proposed because of the perceived need for an accepted basis for the development of long-range plans for the future direction of NASA. In recent decades, a single major project (e.g., Apollo, Shuttle) has tended to drive and focus NASA's goals and objectives. In view of the impending completion of the development phase of the Shuttle, it is now timely to reassess the long-term mission objectives against which NASA should base its future activities. Such a reassessment is also timely in view of the very large technical base that has been built up in NASA, and the fact that other agencies, nations, and the private sector are now involved in space to a degree not foreseen by the National Aeronautics and Space Act of 1958.

Although the general outlines of the "next step"--development of a permanent U.S. presence in space--had been identified by the President's July 4, 1982 statement of space policy, the Council felt that this particular goal was in fact a near-term one, and would not alone serve as a satisfactory framework for a comprehensive long range plan. Thus, the study was designed to consider NASA's long-range missions and their relation to the goals, policies, and institutions of the United States in the context of current national policy priorities. The specific Terms of Reference for the study are provided in Appendix 1 to this report.

It was not the purpose of this study to identify and define specific projects or programs for the future, although some such programs may be noted in the context of the larger theme.

The membership of the Task Force for the Study of the Mission of NASA was drawn from the membership of the NASA Advisory Council, augmented by additional participants, representing the requisite areas of expertise, and named to the Council as Associate Members for the purpose of conducting this study. The membership of the Task Force is also listed in Appendix 1.

At the outset of the study, the Task Force examined the statutory and policy basis upon which the mission of NASA would necessarily rest. The main elements are the Space Act, as amended, the National Space Policy announced by President Reagan on July 4, 1982, and the Aeronautical Research and Technology Policy reported by the Office of Science and Technology Policy, Executive Office of the President, in November 1982. Appendix 2 contains a brief summary of the relevant statutes and policy directives that apply.

The Task Force then set out to identify the issues, carry out fact finding and analysis, and then determine its findings, conclusions, and recommendations. The study approach is described in more detail in Appendix 3. Our principal finding and recommendation of the mission of NASA is stated in section B, following. Section C contains more detailed examination of specific NASA missions that together contribute to the whole, and Section D notes some concluding remarks.

B. THE MISSION OF NASA

At the end of its deliberations on the many elements of the missions of NASA, the Task Force reached a consensus on a carefully worded statement that concisely expresses the "Mission of NASA" that rests on current statute and policy and provides a framework for NASA's program thrusts for the next 20 to 40 years:

> Mankind has acquired the ability to move within and beyond the confines of the surface and the atmosphere of Earth, creating apparently limitless opportunities for beneficial human activity. In this regard, NASA has a dual mission--in space and the atmosphere--portions of which are overlapping.
>
> NASA's space mission is to conduct activities on behalf of the people of the United States in collaboration with other nations, to:
>
> - explore the solar system and study its planetary processes, including, as appropriate, those governing the Earth, for the benefit of humankind
> - pursue a program of fundamental scientific research in space to expand human knowledge
> - plan and implement space technology programs and research into the use of the environment of space in order to provide for the continued advance of the national space capability and its exploitation for public and commercial purposes
> - and, to achieve these ends, create the capability for an expanded human presence in space and develop and assure the operation of launch and space vehicles.
>
> NASA's mission in aeronautics is to maintain, and augment as appropriate, an aeronautics research and technology program which contributes materially to the U.S. leadership in civil and military aviation.

The Task Force believes that it is inevitable that human habitation will eventually extend beyond the confines of the Earth in many ways and on a scale far larger than is currently envisioned. Although it may not now be productive to debate the specific nature or the timing of this most dramatic of all human ventures, it is appropriate to use such a venture as a distant goal to guide our search for an understanding of the solar system and to stimulate the further advance of humankind.

C. KEY MISSIONS CONSIDERED

In arriving at the broad statement of the Mission of NASA presented in the preceding section, the Task Force concentrated its efforts in those mission areas which it determined to be most critical to the long range goals and objectives of NASA in its role in managing and implementing its portion of the national space program. These mission areas, which are discussed in the following pages, are believed to be those which will most influence the organization, roles, and resource needs of NASA in the next 20 to 40 years, and include:

- Exploration of the Solar System, Including Planet Earth, for Human Benefit
- Fundamental Space Science
- Space Technology
- Space Applications
- STS Operations
- Aeronautics
- Human Spaceflight Research
- International Relationships.

1. EXPLORATION OF THE SOLAR SYSTEM, INCLUDING PLANET EARTH, FOR HUMAN BENEFIT

NASA's mission in space science can be considered in two distinct parts: one is space science conducted to contribute directly to human welfare and national need, and the other is fundamental science conducted to expand human knowledge. In principle, both can include the full range of space science disciplines, such as astronomy, space physics, and planetology. Often the experiments, the instruments, and the data gathered are the same, but the differing objectives and motivations may yield a vastly different scale and pace of endeavor. This section considers NASA's mission in solar system exploration (including the planet Earth) with the goal of utilizing the resources and knowledge acquired for human benefit. The next section considers the mission of NASA in space science for the expansion of human knowledge--science as an intrinsically valid cultural activity.

a. Issue - What should be the mission of NASA in exploration of the solar system, including investigation of our own planet Earth?

NASA's mission in the exploration of the solar system contains two related parts, which together provide a major objective for NASA for the next half century. The first involves exploration of the solar system with an eventual goal of utilizing the resources and knowledge of space for human benefit. The second brings a planetary perspective to our own planet and leads to the goal of understanding those global processes especially important to humanity.

We offer the following commentary on these goals. This commentary has emerged from consultation with members of the Mission of NASA Task Force as well as some fifty other interested spokesmen from the scientific, education, media, and public leadership communities.

b. Solar System Exploration - Discussion and Findings

The human ability to move at will through the solar system has created great opportunities to which the U.S. must continue to respond. NASA is the only agency with the charter and the skills to carry through the course of action required for further expansion into the solar system. Exploration of the solar system offers a central objective for NASA's activities in the coming decades because it demands creative innovation; it calls for both scientific research and technology advance; and it is ready to be undertaken.

A deeper understanding of the solar system is, by itself, a cultural goal of high priority and scientific research has in the past provided a convenient tool for extending the human presence into new environments. A more distant goal, however, is the use of the material and energetic resources of the solar system for the benefit of humanity. The path from our present state of knowledge to this distant goal has yet to be defined, but a strategy aimed at defining that path should be feasible. Considerations governing the provision of living space and the exploitation of raw materials and energy should be studied and from them an exploration strategy should be built. The return of planetary samples is feasible, as are robots and telefactors and other innovative devices; Earth crossing asteroids can provide planetary materials for analysis and to assist in the design of missions.

The goal of exploring and understanding the solar system will involve varying degrees of direct human participation and of automation. A direct human presence in space is desirable for cultural reasons and for reasons associated with human powers of rapid observation, integration, reasoning, and reaction. The extent to which people can work in space even on a time-scale of months will depend heavily on our commitment to solve fundamental ecological and biomedical problems. The continuous habitation of space will require development of wholly new environmental support technologies drawing upon our basic understanding of terrestrial ecological systems. Routine or production chores, work in hazardous or unknown environments, and the conduct of tasks not warranting the expense of creating ancillary human ecological systems, should be automated. A more aggressive pursuit of the technologies of robotics, teleoperation, and machine intelligence is required to maintain a proper lead and balance in designing NASA programs and will lead to beneficial applications to industrial and scientific endeavors on Earth, as well.

If NASA does not now continue with a vigorous program of solar system exploration, technical skills will be lost, essential facilities will be discontinued, and a laboriously assembled community of planetary scientists will be dispersed. The crucial question is the maintenance of the U.S. leadership in space. If our leadership is to be maintained, NASA must continue to advance. NASA must clearly delineate its commitment to explore and understand the solar system. NASA's declaration of this goal offers one of the best opportunities to retain our preeminent position in space.

An extended program of solar system exploration requires a broader national commitment than that which presently exists. Planetary exploration has been viewed in the past either as a science project or admired for its spectacular first views of solar system objects. Execution of the program has been based on a project-to-project approach. If NASA is to shoulder an enduring commitment to extra-terrestrial activity, it must follow a strategy extending over a number of decades, and cannot depend upon year-to-year budgetary competition nor can it depend upon budgetary exigencies in other parts of the Agency. The objective and the plan must be put persuasively to Congress and the U.S. public, and management must seek ways to preserve the integrity and momentum of the program.

NASA's past experience in conducting planetary programs testifies to the ability of the Agency to implement a solar system exploration program. The relative priorities of activity in the inner and outer solar system depend upon the objective. Concentration on specific targets will ultimately be required. Economies in launch costs are possible if missions take place on a regular basis and if we accept a discipline of minimum spacecraft modification. A strategy for the exploration of the solar system employing spacecraft of constrained cost has been put forward by the Solar System Exploration Committee of the NASA Advisory Council, and constitutes a valuable step in the required direction.

The U.S. is not alone in its exploration of the solar system. The Soviet Union has persevered in a continuous program of exploration of the inner solar system and now Europe and Japan are developing the required capabilities. The effort to understand and utilize the solar system will, at least in part, be an international effort and the U.S. must make vigorous efforts to understand the intent, the objectives, and the strategies of the space agencies of other countries. A thorough and open-minded discussion of all aspects of international cooperation is essential for future progress.

A commitment to a solar system exploration program requires a continuing series of interrelated flights. The program must have the status of agency policy, to be modified only after careful deliberation and consultation with Congress and with our international partners. The commitment must include adequate funding for ground-based, laboratory, and theoretical work necessary to the program. NASA must work closely with other responsible agencies to fill gaps in the program for which it has lead responsibility.

c. Science of the Planet Earth - Discussion and Findings

As the focus moves from the inner solar system to Earth itself, NASA's mission becomes increasingly involved with those of other national and international agencies. An efficient relationship between these agencies must be maintained, but there are important tasks for which NASA must provide a major effort and assume a leading role.

Global changes, both natural and man made, affecting the human condition have recently become a matter for international concern. Environmental problems will proliferate, but there is an inadequate base of knowledge upon which to make informed judgments. The major components of atmosphere, ocean, fresh water, ice, and land strongly interact with the rapid metabolic and reproductive activities of living organisms in poorly understood, complex ways. Our ability to modify the surface sediments and atmosphere upon which we depend leads us to identify as a crucial goal the determination of the conditions for habitability of the globe. The total productive capacity of the planet for food, clean water and air for people, the cycling of elemental nutrients, and the rates of change of these major factors on the Earth's surface system must be understood.

These problems are global. They involve long time scales because the processes under consideration take decades to complete. Research involving the disciplines of physics, chemistry, and earth and life sciences must be brought to bear upon a single set of objectives.

NASA's capabilities for such a task have been demonstrated. The Agency has been skillful in involving in its work diverse scientific communities from industry, universities, and other agencies. The global character of the research means that observations will depend upon space systems. Advanced communications and information systems are also required and, here too, NASA has unique skills. Freedom from operational responsibilities gives NASA the ability to concentrate on long-term research projects. Finally, the long time scales and global character of the phenomena give a close analogy to NASA's objectives in the rest of the solar system, both as regards instrumentation and research strategies.

Relationships with other agencies remain to be defined, but NASA's responsibilities will be large. Importantly, the task of understanding the processes involved in global surface and atmosphere change will also provide NASA with a program objective which has been lacking in the past. Other agencies have needs in the remote sensing area for which they have traditionally looked to NASA for help and support. To provide such help is a proper part of NASA's mission but if, in addition, the Agency has its own need to develop remote sensing tools, the effectiveness of that assistance will be advanced.

The Agency has not previously made a program commitment on the scale of that proposed here. The implications are important and parallel to those for solar system exploration. On the one hand, a commitment provides stability and a basis for programmatic judgments. On the other hand, it involves a responsibility to carry the research forward over a long period of time, and to consider aspects of global surface chenges, using both ground-based and space systems.

d. Recommendations

The Task Force recommends that:

- The United States, in collaboration with other interested nations, vigorously pursue a program of exploration and understanding of the solar system for ultimate human benefit

- A more aggressive pursuit of the technologies of robotics, teleoperation, and machine intelligence be undertaken to maintain a proper lead and balance in the design of NASA programs
- NASA accept a leadership role in major aspects of the study of the planet Earth, in particular in those areas which concern global changes of importance to the support of human life
- Adequate funding be provided for ground-based, laboratory, and theoretical work as well as for space systems
- NASA seek a lasting national commitment in order to achieve these goals, which will require new approaches to project procedures and budgetary policies including steady funding levels and program continuity.

2. FUNDAMENTAL SPACE SCIENCE

a. Issue - What should be NASA's role in the conduct of fundamental scientific space research?

From the vantage point of the mid-1980s, we can look back at 25 years of unparalleled achievement in human exploration of the cosmos from space. One of the first outstanding achievements of the U.S. space program was the discovery by Van Allen of massive concentrations of energetic particles contained within narrow zones by the distant magnetic field of the Earth. From this beginning has developed an outstanding space science program.

Milestones have included the human investigation of the lunar surface. For the first time the chemistry and morphology of a planet other than Earth was detailed. The planetary research program has been successful in providing spectacular images of new worlds. In turn, these images help in producing knowledge of processes taking place on our own planet. Evidence relating to the potential for life on Mars was sought. While no positive signs were found, the successful Viking mission nevertheless provided a major stimulation to thinking about the origin and modifying effects of life on our planet.

The new view obtained from space has shown us that the sun is a variable star whose effects reach much further than we had thought. We now know the sun's magnetic field stretches throughout interplanetary space to the outer reaches of the solar system. Steady streams and intense bursts of atomic particles blow outward from the sun colliding with the atmospheres of the Earth and the other planets. In particular, at the Earth, this "solar wind" is the energy source for the aurorae, magnetic storms, and the radiation belts. Our exploration of the space environment of the Earth has revealed that a wide variety of complex, changing phenomena--lines of magnetic force, atomic particles, electric currents, and a huge envelope of hydrogen atoms--surround the Earth.

As a result of the U.S. program in space astronomy and astrophysics during the past two decades, a new view of the universe is emerging. Rocket and satellite observations at ultraviolet wavelengths have shown that many types of stars are ejecting enormous amounts of material at high velocities. A revolution is occurring in our knowledge of the chemical composition and physical state of interstellar gas and dust. It is known now, from both ultraviolet and X-ray observations, that many types of stars possess high temperature, tenuous outer layers, and exhibit solar-like activity. Their behavior is not consistent with earlier ideas about the origin of the solar chromosphere and corona, and those ideas, therefore, are undergoing a major revision. Discovery of celestial X-ray and gamma-ray sources has revealed the existence of entirely new types of celestial objects and has shown that explosive events of unimaginable violence occur routinely in the universe.

Current programs, such as the Infrared Astronomy Satellite, and programs now in development, such as the Space Telescope and the Gamma Ray Observatory, will further advance this ongoing revolution in astronomy. It is, in fact, conceivable that a series of long-lived orbiting observatories spanning the electromagnetic spectrum could, by the end of the century, provide answers to ultimate questions concerning the origin and evolution of the universe.

b. Discussion

Achieving the full benefit of the data obtained from expensive space missions requires the development of a comprehensive scientific program involving not only the missions themselves, but also support for theoretical studies, data analysis, laboratory and field measurements, ground-based, aircraft, rocket, and balloon observatories, and development of new instrumentation. Such activities are the foundation of understanding the results from past missions and for preparing for the future.

In fundamental science, NASA shares a responsibility with the National Science Foundation. Working relations between the two agencies have generally been satisfactory, but policy interactions have been limited. The Federal Coordinating Council on Science, Engineering, and Technology provides one framework for policy consideration, but has not been particularly active in recent years. The division of responsibility between the two agencies has created a gray area of ground-based observations and theoretical and laboratory work, all essential for realizing the full advantages of space missions. Furthermore, funding vagaries have created problems in maintaining effectiveness in research capabilities which have been built laboriously over decades. Such funding as exists is often disrupted by the fluctuating costs of spacecraft construction and the priority that such construction has in the work of the Agency.

c. Recommendations

The Task Force recommends that:

- Space science must remain a principal part of NASA's mission because research in space science has become a central element of scientific research in the United States and the prospects for future major advances in this field remain bright
- Adequate and stable levels of funding for ground-based, laboratory, and theoretical research, a key part of NASA's scientific program, be provided independently of the fluctuating needs for spacecraft and instrument construction
- NASA take a lead role in assuring that the activities sponsored by NASA and NSF are properly coordinated.

3. SPACE TECHNOLOGY

a. Issue - Should NASA enlarge its space research and technology (R&T) programs to support the space systems needs of other Government agencies and the private sector, as well as to support its own needs?

For most of the 25 years since its establishment, NASA's work in space research and technology development has been oriented chiefly to future NASA program needs. The principal reason for this was simply that the NASA program dominated the U.S. national space program. The military program was smaller and narrowly focused on communications, intelligence activities, and ballistic missiles, each having highly specialized technology requirements and subject to stringent security controls. Technology for areas of mutual interest and coordination was supported as a subset of the NASA program. Similarly, the commercial program was also not a direct customer for NASA technology developed as a result of programs of its Office of Aeronautics and Space Technology (OAST).

Today, the military space program has grown to exceed that of NASA and continues to grow at a greater rate. In the commercial world, the space communication industry has also grown very rapidly and now operates at an annual level of nearly $4 billion per year. While the remote sensing programs are still government programs, current considerations for commercialization of land and ocean remote sensing, as well as of meteorology, are in prospect over the next decades. Further, the space launch business other than NASA's is likely to grow, with future commercial provision of space launch services employing expendable launch vehicles a distinct possibility. Finally, the space technology capabilities of Japan and Europe in some cases exceed those of the U.S. to the detriment of the U.S. space industry. Vigorous leadership will be necessary to regain the lead in applied space technology.

In light of these changes, NASA/OAST has proposed, in its Fiscal Year 1985 and subsequent programs, to undertake space R&T activities in support of the national space program, in addition to that of NASA. This is the central issue regarding NASA's mission in space R&T that was addressed by the Task Force.

b. Discussion and Analysis

1) Statute and Policy

The relevant sections of the National Aeronautics and Space Act (Appendix 2) do not explicitly restrict NASA to space R&T in support only of its own activities, and would in fact appear to implicitly sanction work in support of other U.S. entities. The same appears to be true of the current National Space Policy (Appendix 2) which encourages the application of civil space technology for national security needs where appropriate, calls for preservation of the U.S. preeminence in critical space activities to enable continued exploitation and exploration of space, and directs the conduct of appropriate research and experimentation in advanced technology and systems to provide a basis for future civil applications.

2) The ASEB Study

At the request of OAST, the Aeronautics and Space Engineering Board of the National Research Council reviewed the space R&T program in the summer of 1982 and made certain recommendations regarding OAST support not only of NASA, but also of the national space community. The review examined both civil and military requirements in a number of critical technologies in considerable detail and reported a comprehensive set of conclusions and recommendations for the NASA space R&T mission. The ASEB workshop recommended that the OAST space R&T program should be redirected to address the needs of the broad national space constituency, and endorsed the concept of an OAST role in space technology analogous to its role in aeronautics. Because the Space Act authorizes aeronautics and space activities (other than development and operation of space vehicles) in essentially identical terms, the established role of NASA in aeronautics to support the national needs (Appendix 2) provides a model for consideration of the space R&T mission.

The workshop also recommended establishment of a level of investment in space R&T sufficient to fulfill the broadened mission, increased participation by industry and universities in planning, increased cooperation between NASA and DOD, and the development in NASA of centers of excellence in critical technologies. The potential for on-orbit space experimentation was singled out as a unique NASA capability for zero-gravity, vacuum, and radiation research equivalent to the aerodynamic wind tunnels in aeronautics R&T.

c. Findings and Conclusions

The Task Force concurs with the recommendations of the ASEB study that the NASA mission in space R&T should include support of the space technology requirements of the U.S. national space endeavor, including the military program, the space programs of other government organizations, and those of the private sector, as well as that of NASA itself.

1) Funding Level for Space R&T

The Task Force observed that the level of funding for space R&T, both in absolute and relative terms, has declined significantly during the last decade or more. An increase in funding is needed to provide the advanced technologies appropriate to future space programs. It is clear, however, that NASA's resources will not be adequate to permit OAST to pursue all promising technologies above a base level even if judicious increases are applied. Because NASA cannot, and should not, provide all space technologies to all users, OAST's space R&T priorities must be carefully defined.

2) NASA-DOD Relations in Space Technology

There are many areas of space R&T where NASA can contribute to the DOD space program, but there are also distinct differences, primarily in program acquisition methods, which can affect the transfer of technology between NASA and DOD. The current NASA orientation is toward projects of broad scientific interest conducted on an unclassified basis, often with international participation. NASA projects can also include significant involvement by several quasi-independent NASA centers each with certain technical specialties and all brought together by a program management structure which flows from NASA Headquarters to all participating elements, including industrial contractors. DOD technology projects, on the other hand, deal for the most part with specific military missions, are frequently highly classified, and have a strong interrelationship between the mission and the technology used. These projects are managed by one of several project organizations which work with an industrial contractor team to produce the desired system capability. Overall program management rests with the Air Force Space Technology Center in Albuquerque, NM.

Truly joint programs or a single program in space technology are very difficult to organize and manage because of the mission-peculiar nature of DOD's requirements. NASA's policy of technology transfer both within the U.S. and abroad, and the issue of accommodating the specific needs of high priority defense programs within the existing NASA management structure, make it difficult for NASA to provide the close, timely, and effective support needed by the DOD programs.

Coordinated programs, on the other hand, are much more readily achieved. Presently two interagency groups exist to coordinate NASA and DOD programs, the DOD/NASA Aeronautics and Astronautics Coordination Board (AACB) and the Air Force (AFSC)/NASA(OAST) Space Technology Interdependency Group (STIG). Perhaps because of NASA's concentration on the STS in the last decade, vitality of the AACB has tended to weaken and that interaction in space technology has become essentially an ad hoc relationship. On the other hand, the STIG has become increasingly active in selecting key technology areas for emphasis and in assuring that joint activities are properly coordinated. Coordination is also furthered through the exchange of key NASA and Air Force personnel.

3) The "Facility" in Space

A leading reason for NASA's central position as the principal supplier of aeronautics R&T is the unique institution established over the course of nearly 70 years, consisting of a high quality research staff, unmatched test facilities, and a long tradition of productive contribution in the field of aeronautics. In space R&T, NASA's position is less unique, because the space industry has developed a comparable capability in the course of carrying out NASA and DOD space programs. The developing capability to conduct space experimentation on or with the support of the Space Shuttle now provides NASA with a unique resource for space R&T which is critical to the technology needs of many space users. A space station could provide an even greater laboratory capability in space--a "field center"--that would be truly unique in this regard. The development of such facilities lends credence to the analogy between NASA's R&T missions in aeronautics and space. The Task Force believes that the Shuttle should be further exploited with on-board experiments and serviceable free flyers for this purpose as soon as possible, both to meet near-term R&T objectives and to lay a foundation for the use of space stations for in-space research and technology development.

4) Space Technology Planning

NASA some years ago developed a Space Systems Technology Model and has updated it periodically. Its purpose is to provide a focus for technology program planning by defining likely future NASA missions, their technology requirements, and technology development programs required to meet the requirements in a timely way. The Air Force has a comparable model for their space missions. To support truly national space R&T needs, the Task Force believes that the NASA model will need to be broadened to take into account the future mission needs of other civil government users and the private sector. The USAF model will need to be employed as source material to help identify potential areas of support to DOD. However, care must be taken not to couple technology programs too closely to future mission plans, not only of others but also of NASA. Such plans are subject to major change, and an effective space R&T program must maintain stability and continuity in the great majority of its elements.

d. Recommendations

The Task Force recommends that:

- NASA's mission in space research and technology be supportive of total national requirements, considering future needs of the civil, military, and commercial sectors. In terms comparable to those for NASA's mission in aeronautics, NASA should have the mission in space R&T to:
  - Fund, direct, and implement space research, technology, and demonstration programs in support of its own and other civil space activities; and support DOD technology needs where the results have broad application and are not duplicative of other government-funded effort
  - Encourage and facilitate, together with other appropriate agencies, the transfer of space R&T results to and within U.S. industry
  - Manage, maintain, and operate space research, development, test, and evaluation facilities. Use of the Space Shuttle and eventually a space station as a laboratory facility in space should be exploited for development of new space technologies.
- Funding for NASA space R&T be increased selectively to permit implementing these recommendations. The following criteria are suggested for identification of technologies to be accorded high priority:
  - The technology is in the national interest and will fill a reasonably established future requirement.
  - The technology offers payoff significantly greater than that presently available at a reasonable cost and is at least comparable in payoff and cost to alternative approaches to the same end.
  - The technology program is not likely to be undertaken, on a timely basis, by others, either public or private.
  - The technology is in an area in which NASA already has a demonstrated capability, or if in a new area, is one in which NASA can readily build the capability and expertise without duplicating an equivalent capability outside.

- Funding augmentations in high priority technologies be provided only after reasonable assurance that ongoing technology developments of little potential value are being phased down and that a base level of more basic research is being maintained across the full spectrum of disciplines to assure that new technology opportunities applicable to future missions are not missed.

4. SPACE APPLICATIONS

a. Issue - What is the extent of NASA's mission in the application of space systems and technology for beneficial purposes on Earth; specifically, how far should NASA go to provide utility demonstration and early operational use?

Historically, NASA has not established a clearly defined mission in space applications. The NASA role has changed over time and has been quite different for each of the major applications areas, i.e., telecommunications, meteorology, Earth resources, and materials processing in space. There are even questions as to NASA's responsibilities in research and technology development in some of the applications areas. Further, there is much concern about how far NASA should go to provide utility demonstration and early operation of space applications systems.

b. Discussion and Analysis

Over the years, a workable institutional arrangement has evolved for the telecommunications and meteorological communities, largely because there was a well organized system of suppliers and an infrastructure that could immediately accept the output of a space system. Conversely, an institutional scheme has not been developed for Earth resource applications, presumably because there has not as yet been aggregated a user market with enough total financial benefit to pay for the system.

There is strong sentiment in the Earth resource user communities that NASA should be chartered both to identify new applications of important national interest and to carry development programs forward until there is sufficient aggregation of the user market to make operations commercially viable or until another government agency is prepared to assume responsibility for them. However, there is criticism of NASA's past approach and emphasis.

On the LANDSAT program, more emphasis during development should have been placed on the needs of the end users. Communication with the users has been impeded by serious deficiencies in the processing and timely distribution of remotely sensed data. In the future, much more emphasis should be placed both on expediting the transfer of data to a wide user audience and on insuring the users of data continuity.

NASA's role in space applications should be compatible with the overall mission of NASA. The present assumption is that NASA's primary focus should be on space research and development, with involvement in operations only if necessary. The other working assumption is that NASA's primary emphasis should be on the civil side, although support of military and other defense interests is not excluded.

Space applications will benefit from NASA's strong motivation for developing remote sensing instrumentation for its Earth science mission, but a better definition of the NASA mission in space applications is needed.

c. Recommendations

The Task Force recommends that the NASA mission include the study of space and space technology for civil applications, by:

- Continuing the identification of possible civilian applications of potential value and by conducting preliminary studies of potential benefits, users, and markets

- Taking the leadership (with interested appropriate agencies) in systematic reviews of existing and possible civil applications of space with the formal involvement, in an advisory committee structure, of selected participants from the prospective users and providers of services in the private, public, and academic sectors; the pertinent scientific, technical, and industrial communities; and the interested civil and defense agencies of the Federal government. The purpose of the reviews is to identify requirements and priorities for research, technology development, test and demonstration, user experimentation, and market development

- Conducting or supporting research and technology development on essential components and subsystems of space and ground systems for civil space applications, where such research and development is not being, and cannot reasonably be expected to be, conducted and paid for by the private sector or by the Department of Defense or another government agency

- Conducting, with suitable cooperative arrangements with the private or public agencies, tests, demonstrations, and experimental user operations of new types of spacecraft, spaceborne systems, and ground systems for civil space applications in cases where:

    - Potential advantages, uses, and users have been identified

    - The private sector or other agencies cannot reasonably be expected to pay the full cost.

  Administration recognition of this mission of NASA should be sought.

- Arranging for the transfer of useful applications systems employing space technologies to private or public agencies as appropriate; unless it is in the national interest for NASA to become the operating agency.

5. SPACE TRANSPORTATION SYSTEM OPERATIONS

a. Issue - What are reasonable and basic options for managing and operating transportation to and from space from the present to the late 1990's and beyond? What are the relevant evaluation criteria for, the steps to be taken in achieving, and the time phasing of any recommended changes in the management of STS operations?

Because of the immediate importance of near-term Shuttle operations to the future space activities of NASA and others, and because of the size of the management structure and infrastructure required to achieve an efficient and utilitarian operation as soon as possible, the question of NASA's management role in Shuttle operations--both now and in the future--is an important influence on NASA's future mission.

The Space Shuttle project was undertaken to provide a means for the reliable and efficient transportation of payloads, spacecraft, and space research facilities to and from low Earth orbit. In addition, the Shuttle was developed to provide a capability for satellite retrieval and in-orbit spacecraft repair, as well as to provide an Earth orbital facility for the conduct of spaceflight experimentation, space research, and development of applications of space technology. The development phase of the Shuttle is nearing a successful conclusion and the operational phase of STS operations is beginning. Development costs greater than expected and flight rates lower than forecast have prevented the Shuttle from achieving its initial payload-to-orbit cost objectives. Nonetheless, the needed improvements are being made and the Shuttle continues to represent an increasingly valuable national resource.

b. Management Options for STS Operation

The Task Force believes that realization of the maximum operational efficiency for the Shuttle is an immediate task which presently requires a major amount of attention from senior NASA management. Concerns have been raised that the continuation of the current management approach will create a serious diversion of NASA resources and attention from its more traditional roles of aeronautics and space R&D and space exploration and experimentation. Some believe that the continued management of routine Shuttle operations is also in conflict with the basic role of NASA. Others have expressed the view that NASA (or any government agency) is not the proper organization to achieve the operating efficiencies, levels of customer satisfaction, or degree of market development desired. Therefore, the resolution of the technical and management issues involved in Shuttle operations can have major impact on future NASA missions.

Consequently, a number of other options for the management of STS operations have been suggested:

- Full Commercial Management - An industrial organization which would assume full direction of operations and management of the STS operational facilities, with profit as an operating objective.

- DOD Operation - DOD would assume NASA's present role to provide Shuttle services and support of STS operations for all government and non-government users. Dividing the current Shuttle fleet between NASA and DOD is considered a combination of those options and is not addressed separately.

- Separate New Government Agency - This approach would create a new Federal agency to manage Shuttle operations. It would most likely assume ownership and management of the present NASA facilities and personnel resources devoted to Shuttle operations.

- Quasi-Government Corporation - A quasi-government corporation would be created with many of the features of full commercial management but with the government having a "tighter hold" on Shuttle operations. This could permit further recognition of the national resource value of the Shuttle.

- New NASA Organization - This would be a new organization within NASA with an explicit mission statement for Shuttle operations which encompasses and limits its responsibilities in a carefully defined way. Funding, personnel, and facilities, together with the necessary liaison, support, joint use, and operating agreements, would be provided as appropriate. These would be "fenced" (i.e., segregated) within NASA to focus solely on management of Shuttle operations and their evolution, with specific proscriptions against encroaching on other NASA interests or vice versa.

- As Is - Shuttle project/operations would remain a mainstream NASA management activity (with the Air Force responsible for the activation and operation of the western launch site at VAFB) utilizing the widespread and integrated capabilities now in existence, but augmented by increasing contractor support of operations at KSC and VAFB. Customer service levels and market development will gradually improve and cost to orbit will gradually decrease.

In the course of its fact finding, the study group met with senior NASA management officials and program and operations executives, as well as with policy makers and senior operations managers in DOD. Other discussions were held with user organizations and members of Congress, the Executive Branch, and industry. Factors used in coming to the conclusions and recommendations reported herein included the following:

- Support for and participation in NASA's basic mission of aeronautical and space R&D, including advancement of the role of man in space and development of a permanent manned presence in space
- The cost effectiveness, flexibility, and reliability of Shuttle operations
- Market development factors, including user satisfaction, potential for profitability, and conditions for improving load factors
- The impact of the option under consideration on NASA, including effective utilization of manpower and facility resources and diversion of resources and attention from mainstream R&D activities
- Potential for further evolution of the operational Shuttle system and management organization
- Political acceptability, including adherence to current law and policy and effects on the public image of NASA.

Because a detailed study of Shuttle utilization has been done in parallel with this study, ("Shuttle Utilization Study"), the factor of customer support was not studied in depth in our evaluations. Similarly, it was determined that the very topical concern regarding the future of expendable launch vehicles (e.g., backup capability, schedule flexibility, heavy lift capability, competition, etc.) currently being addressed by many went beyond the scope of this review of STS operations.

c. Discussion and Findings

The Shuttle is beginning to demonstrate its potential utility for launch services and its unique capabilities as a national resource for manned spaceflight, defense missions, space science support, research and technology development in the space environment, satellite retrieval and repair, and international activities.

At present, the Shuttle fleet is small and the operational system is immature. There is some user concern over the availability, cost, and schedule reliability of service, but this is being resolved as Shuttle operations, payload processing, and customer services improve. Launch rates have not reached earlier projections and the market development capabilities of NASA are in an early stage and possibly limited by statute and policy.

As was the case with the development of all major modes of transportation throughout history (e.g., ships, railroads, airplanes, and automobiles), the Shuttle STS will require some level of continued Government financial support if it is to mature to its full operational utility and efficiency. The fact that the Shuttle currently represents the only U.S. manned spaceflight activity and capability, plus its other national resource aspects, would appear to justify fully continuing public support, especially during its maturation phase (perhaps 5 or 10 years). Although the present Administration has emphasized cost recovery, in part to provide incentives for improvements in Shuttle operational efficiency, concern is expressed by many that the users of Shuttle delivery services will be required to underwrite some of the special costs related to achievement of the national resource capabilities of the Shuttle.

NASA is noted for its research and development capabilities, but has had only limited opportunities to develop the management and operating skills required for routine Shuttle operations. NASA is presently learning what is required to achieve routine and fully efficient operations (i.e., "airline" type service), and is taking appropriate steps to reduce further operating costs and to control cost growth by such means as the consolidation of contractor support. NASA management is sensitive to the impact that a preoccupation with operations and Shuttle funding can have on its more traditional roles and unique R&D capabilities. In addition, this is a time of growing interest within the Agency in the development of a space station. Just as the heavy management load required for Shuttle development diverted attention and resources from other NASA activities, so might the undertaking of a major space station development effort similarly divert management attention from Shuttle operations. This also suggests the advantage of some type of formal segregation of R&D and the operational function.

The transfer of Shuttle operations responsibility to a non-NASA management organization is complicated by such factors as the large infrastructure of management, personnel, facilities, and management systems that would need to be shifted to or duplicated by a non-NASA operator; the present level of governmental financial support required for Shuttle operations which is likely to continue to be necessary for some years to come; and the needs of DOD for secure operations as well as a requirement, in time of crisis, for priority over commercial and other payloads.

DOD has indicated that it is not interested in a major expansion of its Shuttle operations role at this time, and potential commercial operators would require substantial subsidies and guarantees for probably many years to come. The present state of Shuttle operations and the need for continuing evolutionary development and sustaining engineering support would make operation by an organization other than NASA quite difficult at this time. Also, the national resource aspects of the Shuttle further complicate the option of management by a full commercial operator.

A partial evolutionary step would be an operating organization within NASA which is focused on the management of on-going Shuttle operations but which is constituted in such a way as to minimize the concerns regarding diversion of resources from NASA's R&D programs. Also, such an organization should be established in such a way as to maximize current strengths and avoid a potential disruption in the work of the Agency in activities not related to the STS. These requirements can be satisfied by the further segregation of the Shuttle operations organization within NASA and by fencing its resources from other parts of the Agency. Among the advantages to be obtained by such fencing of resources are the ability to bring total management focus on the objectives, mission, and responsibilities of Shuttle operations, as well as to permit clear delineation of the total resources (manpower, facilities, and fiscal) required to accomplish the management of Shuttle operations. Such fencing can enable--or can lead to--more operationally effective and cost-effective means of accomplishing the objectives of the Shuttle program than would likely be achieved by an organization which has a larger mission and other related goals and objectives. Another factor to be considered (which may be positive or negative) is that such fencing places limitations on the flexibility of the Administrator to employ his total Agency resources for the vast number of purposes he must achieve, but does help to protect the R&D budget from encroachment by operations funding requirements.

The study group also examined briefly issues associated with both expendable launch vehicles (ELVs) and future heavy lift launch vehicles. Availability of ELVs, as a backup to Shuttle, for schedule flexibility, or for Shuttle competition (as well as the related commercial pricing considerations of ELVs), is recognized as a serious issue which needs to be resolved by NASA in conjunction with other interested parties. The Nation's present lack of a capability for heavy lift to orbit is also of concern. While studies of such a capability are known to be underway, NASA should devote increased resources and attention to this matter in view of the possible future need for such a capability and the development time required for its realization.

d. Conclusions

The study group has come to the following conclusions regarding the management of Shuttle operations:

- The present small size of the Shuttle fleet, its lack of maturity and high cost of operation, and the lack of DOD interest in assuming full operating responsibility all militate against shifting Shuttle operations outside of NASA in the near future.
- The Shuttle operating management organization should be fenced from the rest of the NASA organization.

- That organization should be charged with improving the quality of customer service and enhancing the development of Shuttle marketing capabilities.

- The Space Shuttle has a value both as a launch service for a wide variety of government and non-government users and as a national resource (e.g., manned spaceflight, DOD mission support, satellite retrieval and repair). The national resource attributes will continue to require government financial support for some time to come.

e. Recommendations

As a result of the extensive fact finding, discussions, and analysis carried out by the study group, the Task Force submits the following recommendations regarding NASA's future role in the management of STS operations:

- A new NASA organization be created at the appropriate time within NASA to focus on Shuttle operations and utilization, including marketing activities and sustaining engineering support. This organization, which should be headed by a Deputy Administrator, should have fenced manpower, finances, and facilities

- The Shuttle Operations organization continue to enhance customer services and market development activities through the application of resources both internal and external to NASA as appropriate. Consideration should be given to contracting out the market development activities

- The Deputy Administrator for Shuttle Operations be charged with proposing the evolutionary steps for future management of Shuttle operations

- The Shuttle operations organization not undertake future STS development activities, such as a follow-on Shuttle or new launch capability, but should help define future requirements for such major improvements

- The value of the STS as a national resource due to its unique capabilities to provide for manned spaceflight, defense missions, space science support, and research and technology development in the space environment, as well as its special capabilities for satellite retrieval and spacecraft servicing, be recognized. The total costs associated with this national resource value should not be charged to the Shuttle's launch service users

- As markets for the STS develop, NASA consider shifting pricing of Shuttle services towards an incremental (i.e., institutional) cost basis. This is the usual practice in NASA research facilities and, given the national resource character of the Shuttle for civil and military Government programs, is more appropriate than pricing on the basis of total recovery of recurring costs (industrial funding).

6. OTHER MISSION AREAS

NASA-DOD relations were extensively discussed; recommendations on this important matter are contained within the sections on the missions (i.e., STS Operations, Aeronautics, Space Technology), rather than provided separately. The missions of NASA in Aeronautics, Human Spaceflight Research, and International Relations were also given consideration during this study. They were not, however, examined in quite the detail of those discussed in the preceding sections, and are therefore summarized in this section.

a. Aeronautics

When the Task Force was first established, the issue of NASA's mission in aeronautics was thought to be one that would require a great deal of attention as a result of questions raised in recent years of the role of the Federal government vis-a-vis that of the private sector. However, before the Task Force study got underway, a broad policy statement on the Federal mission in aeronautical research and technology was released by the Administration (see Appendix 2); it resolved most of the elements of the issue that would have been considered. Regarding NASA, the policy reaffirms NASA's responsibilities in aeronautics to:

- fund, direct, and conduct research and technology development programs
- support military technology demonstration programs
- with the Department of Defense, manage, maintain, and operate research, development, test, and evaluation facilities.

On the basis of this new statement of NASA's role in aeronautics, the Task Force agreed that aeronautics was no longer a major issue for this study, but gave some attention to two derivative issues, demonstration of technology for civil aviation, and effective relations with the DOD, as follows:

1) Demonstration of Civil Aviation Technology

NASA for the last 25 years, and before that NACA since 1915, has performed a highly successful research and development function for all aspects of aeronautics. NASA has supported both civil and military aviation with R&D conducted by skilled scientific people in unique laboratory facilities. The recent Administration policy study and, before that, the report of the Aeronautics and Space Engineering Board (ASEB), "NASA's Role in Aeronautics," 1980, reaffirmed the importance of aeronautics to the Nation and the role of NASA in supporting both civil industry and DOD, a position with which the Task Force is in full agreement. The Administration's policy study report went into considerable detail describing the three phases of this support: research and technology development, technology demonstration, and system development, and clearly established the role of NASA with respect to DOD in all three phases. However, the policy limits the role of NASA with respect to civil aviation to the first phase only (R&T development). The Task Force feels strongly that there are, from time to time, important national objectives which require NASA support of the civil aviation industry in the second phase (technology demonstration), and that it should be possible, on a case-by-case basis, to provide that support. Such support has been provided in the past (e.g., the Aircraft Energy Efficiency Program) and should not be precluded in the future.

The Task Force recommends that:

NASA's mission in aeronautics include, subject to specific approval, support to the industry in civil aviation technology demonstration programs provided that they are in the national interest, the industry cannot effectively conduct the programs without that support, and the support fits naturally within NASA's capabilities.

2) NASA-DOD Relations

NASA's support to the DOD in aeronautics is fully mandated by the Space Act and the 1982 aeronautics policy statement. Because of the importance to the Nation's security of this NASA mission, the Task Force recommends that:

- NASA continue to assist, communicate with, and cooperate with all branches of the DOD in all matters relating to aeronautics. The first priority should be in R&T areas of the basic technologies of aeronautics and should include providing access to and utilization of both human resources and laboratories and other physical test facilities as appropriate. The second priority should be in mission-oriented systems work as requested, or when special expertise or facilities are available
- Continue to strive for excellence in the basic technologies of aeronautics
    - Establish, build up, and nurture "centers of excellence," (the quality of people employed is critical to the success in this area)

  - Establish, provide, and keep up-to-date physical resources, i.e., laboratories and test facilities uniquely capable of supporting the technologies.

- Continue to provide an advisory committee structure to promote communications between NASA and DOD, as well as with industry and academe
  - At top management levels of the respective organizations to monitor overall planning and performance
  - At working levels to be certain of continuing detailed technical communication. This should be in both directions.

- Be prepared to work in classified areas when appropriate. This will probably be a requirement to be effective in mission-oriented systems areas.

b. Human Spaceflight Research

Brief sojourns by humans in space to date have caused changes that appear, for the most part, to be within the human physiological tolerances for most people. To fly people safely in space for short periods, it has only been necessary to provide thermal protection and an adequate supply of oxygen, water, and food, and to avoid traumatic decelerations on return. An acute short period of space motion sickness has been a problem in short flights, but appears to be of more significance to mission performance than to astronaut health. This syndrome is currently under study and there is hope of effective countermeasures in the not-too-distant future. Everyone that the United States has sent into space, even for periods as long as several months, has been able to resume normal activities on return to Earth, and the same appears true of the Russian program so far as direct effects of exposure to zero gravity in a spacecraft are concerned.

Some effects of zero gravity, notably on bone and muscle, have continued to increase with flight duration up to the length of the longest missions flown to date. There is, at present, no assurance that these effects will not progress with increasing flight duration until they pose a serious problem for astronauts either on their return to the Earth's gravity or even to continued exposure to zero gravity. Thus the simple measures adequate for short duration flight will not be adequate for these longer missions, which will present problems that are more difficult to deal with and which require solutions not now in hand. At least five classes of problems are foreseen:

1) Exposure to Zero Gravity

Major changes occur in the cardiovascular system and in bone and muscle with long-duration exposure to zero gravity. Additional hematological, immunological, endocrine, and other changes may emerge with further studies. Some may be transient, but others may impair efficiency and may even be life threatening. The development of effective countermeasures for most of the disturbances appears, in principle, feasible, but it should be noted that this type of research characteristically requires iterative studies over many years to reach fruition. Basic research supported by the Agency has provided a basis for the effort and will continue to be an essential component. But, if the Nation is not to be constrained by health considerations in exploration of space by manned vehicles well into the 21st century, it is essential that a major program on countermeasures be initiated now. As a measure of the effort required, note that in earth-bound medicine for conditions whose pathophysiology is better known at the start than is the case in zero gravity, development of a single new drug may cost an average of about $50 to $100 million.

2) Provision of Oxygen, Food, and Water

The maintenance of a habitable environment in space for long periods of time requires long-term original work for the solution of the problems involved. These problems include regeneration of oxygen, purification of water and atmosphere, production of a nutritionally adequate diet, the recycling of waste, and the maintenance of an ecological steady state, if other living organisms are present. Validation of space systems of proven reliability will require many years of work to overcome the significant technical problems.

3) Provision of Adequate Social and Organizational Environment

The scientific basis for the organization of cooperative teamwork of individuals in extreme isolation and confinement for prolonged periods is limited. It is known that the Russians, partly on the basis of their experience with long flights, regard behavioral and social problems as formidable obstacles to be overcome before long space voyages can be launched. It is likely that entirely new principles of human interactions and group dynamics will be required for effective operations. We cannot now predict how long it will take to develop the necessary science and technology.

4) Exposure to Ionizing Radiation

Protection is needed against both the long term cumulation of radiation and the maximum solar outbursts during the period of a voyage. The nature of the problems posed by radiation are better understood than the problems discussed in the preceding sections. However, generally acceptable solutions are not available, so research and development must continue, particularly if pharmacoprophyllaxis is to be part of the protective scheme.

5) Extra-Vehicular Activities

It appears that space station activities and eventual interplanetary flight will require assembly, support, and launch facilities in low Earth orbit on a scale quantitatively much greater than has been accomplished to date. The necessary extra-vehicular activities will require development of a space suit that will permit hard work and manual dexterity, repeated reliable use, and simple routine maintenance.

The Task Force believes that it is inevitable that people will seek to explore the solar system, not only by remote sensing or even by automated acquisition of samples, but by being there, and thus ultimately extend the domain of human life beyond the confines of the Earth. Although it is not productive to debate the specific nature or the timing of this most dramatic of all human ventures, implicit is the requirement for mission durations ranging from months to years. Development of the capability to keep people healthy, effective, and well motivated over the long periods required for the manned exploration of the solar system is an essential part of the mission of NASA.

Given the significance of the issues and the lengthy iterative R&D process required, the Task Force recommends that:

> NASA give high priority to the continuing program needed for the development of this capability. Of special interest at this time is research associated with problems of exposure to zero gravity; provision of supportive ambient conditions with special attention given to oxygen, food, and water; provision of an adequate social and organizational environment; exposure to ionizing radiation; and extravehicular activities.

c. International Relationships

Bearing in mind the fact that one of the basic goals enumerated in the National Space Policy statement of July 4, 1982, was to promote international cooperative activities in the national interest, the Task Force determined that some examination of the international aspects of NASA's roles and missions was in order. The examination included issues such as: the adequacy of the Space Act of 1958 as a vehicle for carrying out NASA's international activities in fulfillment of the National Space Policy; export and sharing of space technology with other nations; and the impact of present policies which tend to restrain such international cooperative efforts where technology export is involved. The strong desire of other nations to establish and pursue their own national space programs was contrasted with the economic necessity for these nations to seek international cooperation with NASA and others to accomplish successfully such major efforts in space. Discussed also were the often strong political and economic reasons for the United States and NASA to seek the participation of other nations. Finally, the discussions considered the role and policy of NASA in fulfilling its responsibilities as the lead agency for carrying out this key technological element of the Nation's total relationship with other nations.

The Task Force discussions brought out three principal views regarding NASA's role in the international space arena:

- NASA's international role is very important to the maintenance of the image of the United States as the technological world.
- While there is clearly a role for NASA in support of U.S. foreign policy, there is a need for greater constancy in our cooperative activities in space ventures with other nations. The process through which NASA enters into international commitments is in need of revision to ensure increased governmental consensus.
- To ensure the continuity of complex international agreements, NASA should in certain instances seek the approval of the Congress for multi-year program funding commitments.

The Task Force found general agreement within the Executive and Legislative branches that NASA's role in international activities represents an important adjunct to U.S. foreign policy. This is a result of the extreme visibility and popularity of U.S. space "spectaculars" as well as the scientific and technological importance of space research and exploration which has potential benefits for humankind on a worldwide basis. There was some concern expressed that the value of NASA's role in support of U.S. international relations is sometimes misunderstood or not fully appreciated within the government, and it was suggested that NASA take steps to ensure greater awareness within the government of its value as an instrument of foreign policy.

The European space community is concerned over the true degree of force and effectiveness of ESA/NASA memoranda of understanding and the risk of significant European investments in cooperative space projects which may be unilaterally abrogated by the U.S. government. Also, the U.S. policy on technology transfer was observed to be counter-productive in terms of its limiting effect on the ability of foreign countries to procure American space products rather than have to develop such products domestically.

The Task Force recommends that:

- NASA take the steps necessary to ensure greater awareness within the government of its value and that of its aerospace programs as an instrument of U.S. foreign policy
- Cooperative agreements between NASA and foreign or international agencies be developed and maintained consistent with long-term foreign policy objectives as well as with scientific and technological objectives to achieve a greater degree of constancy and stability.

D. CONCLUDING REMARKS

The Task Force has examined many facets of the mission of NASA. Though we recognize the breadth of NASA's charter as covering both aeronautics and space, we have devoted most of our attention to the space missions, chiefly because the long established mission of NASA in aeronautics has been studied extensively in recent years and strongly reaffirmed in last year's aeronautical research and technology policy statement.

Our studies have addressed NASA's space missions in a host of program areas--science, exploration, technology, applications, and operations--and have included consideration of issues in space flight of humans and in international relationships.

We have not tried to investigate and recommend goals, objectives, specific programs, or projects, either within program areas or Agency wide. We have instead tried to develop the mission(s) of NASA as a framework for planning well beyond the five- or ten-year planning currently conducted by NASA. We urge NASA to begin that longer-term planning to lend a greater sense of coherence and purpose to the programs underway and planned.

NASA ADVISORY COUNCIL
STUDY OF THE MISSION OF NASA

APPENDIXES

APPENDIX 1

TASK FORCE TERMS OF REFERENCE AND MEMBERSHIP

A. Terms of Reference, Mission of NASA Study (approved 7/2/82)

1. Background

The basic charter of NASA was defined by the National Aeronautics and Space Act of 1958, as amended. This act assigned to NASA the responsibility of planning, directing, and conducting certain aeronautical and space activities of the United States with the objective of enhancing the role of the nation as a leader of aeronautical and space science and technology and in its application. The past has seen many significant achievements; the question now is what direction NASA should take in the future to further implement this charter.

The question of NASA's direction is a timely one. The Space Transportation System, NASA's principal development project for the past several years, is entering the operational phase. There is a significant interest in the Congress and among the public as to NASA's next goals and plans. Some of the policies in other program areas are being reexamined. Further, NASA has developed new working relationships with other Government agencies and with elements of the private sector in its aerospace activities. Finally, the answer to the question must consider the Administration's two top priorities, national security and economic recovery.

The NASA Administrator has asked the Council to study possible missions and the associated relationships, and time-phased goals/programmatic objectives.

2. Study Approach

A special task force under the sponsorship of the NASA Advisory Council will be convened to develop recommendations on possible missions, relationships, and goals/programmatic objectives for the periods of 5, 20, and 50 years. The task force will present its report to the Council for review, approval, and transmittal to NASA management.

Fact finding would begin with the examination of NASA's current policies, plans, and programs in order to define the present state of implementation of the basic charter of the agency. The task force would also consider the perspective of others significant in determining NASA's future direction. This would include:

- o The Administration
- o The Congress

- The agencies and organizations which are users of NASA's products (programs, research and development, facilities, etc.)
- Agencies, institutions, and organizations which work with NASA in the fulfillment of its program objectives.

3. Task Force Membership

The task force will be chaired by George E. Solomon, member, NASA Advisory Council, and will include, in its membership, approximately 5 other members of the NASA Advisory Council or its committees and 5 to 10 associate members, named to the Council for the express purpose of participating in the task force's study.

4. Typical Questions to be Addressed

In carrying out its deliberations, the task force should consider its findings and conclusions in the general context of the following types of questions and issues:

a. Agency Mission

(1) What should NASA specific mission(s) be in this planning period, given the provisions of the Space Act that include (a) expanding our knowledge of atmospheric and space phenomenon, (b) improving aeronautical and space vehicles, (c) developing and operating space vehicles, and (d) preserving the Nation's leadership role in aeronautical and space science and technology.

(2) Is it desirable to maintain the reality and public image of NASA as the lead agency for (a) the nation's open and peaceful program of scientific space exploration, (b) development of space technology for providing benefits on earth, and (c) aeronautical research and development?

b. Relationships

(1) What should be the future relationship between a civilian space program directed toward the peaceful uses of space and a military space program directed toward the exploitation of space for purposes of national security? How can the flow of technology between civilian and military space activities be most effectively accomplished?

(2) What role should NASA play in the employment of the industrial and technical base which supports both NASA and military aeronautical and space activities?

(3) How should NASA involve itself in the demonstration of technology to potential system managers and users in the government and private sector?

c. Goals/Objectives

(1) What should be the goals and time-phased objectives implementing the mission of NASA in terms of future activities in manned space flight, aeronautical research, launch vehicle development, space transportation system operations, unmanned scientific space research, basic research and development, international space cooperation, etc.?

(2) How does NASA's planning for a "permanent presence in space" and "global habitability" fit into the larger context of a redefinition of its future missions and how is it best expressed?

5. Schedule and Cost

a. It is estimated that the study and report preparation will require about one year, with the task force meeting a number of times from the study's inception through June 1983 and possibly including a one-week "summer study" period early in the summer of 1983. A report to the Council is anticipated for about August 1983.

b. Cost is estimated as follows:

	FY 1982	FY 1983	Total
Member Travel	$12.5K	$63K	$75.5K
Member Salary*	0	$12K	$12.0K
Total Cost to NAC Account			$87.5K

Staff support costs will be borne by the appropriate NASA offices within normal allocations.

---

*Summer Study, if included.

B. Task Force Membership

George E. Solomon, Chairman
TRW Electronics & Defense

William A. Anders
General Electric Company

A. Richard Baldwin
Consultant

Philip Culbertson
NASA Headquarters

Peter B. Dews
Harvard Medical School

Daniel J. Fink, ex officio
Consultant

James C. Fletcher
Consultant

Richard Goody
Harvard University

George A. Harter
TRW Inc.

Noel W. Hinners
Goddard Space Flight Center

Lynn Margulis
Boston University

Mike McCormack
Consultant

Frederic C. E. Oder
Lockheed Missiles & Space Co.

James T. Stewart
Lt. Gen., USAF (Ret.)

H.W. Withington
Consultant

Staff:

Nathaniel B. Cohen, NASA Headquarters
Carl R. Praktish, NASA Headquarters
Jane E. Scott, NASA Headquarters
with additional support from Robert R. Irwin, TRW

APPENDIX 2

SUMMARY OF PRINCIPAL STATUTE AND POLICY

A. National Aeronautics and Space Act of 1958, as Amended

The National Aeronautics and Space Act of 1958, P.L. 85-568, was enacted July 29, 1958. In its provisions, it established national policy in aeronautics and space, established the National Aeronautics and Space Administration to conduct aeronautical and space activities, and carefully defined those activities. Relevant excerpts are as follows:

1. Policy and Purpose

Section 102 of the Act contains the basic policy and purpose. The relevant paragraphs are:

> "(a) The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind.
>
> "(b) The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. The Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States) shall be the responsibility of, and shall be directed by, the Department of Defense; and that determination as to which such agency has responsibility for and direction of any such activity shall be made by the President in conformity with section 201(e).
>
> "(c) The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:
>
> "(1) The expansion of human knowledge of phenomena in the atmosphere and space;
>
> "(2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;

> "(3) The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space;
>
> "(4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;
>
> "(5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;
>
> "(6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency;
>
> "(7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in peaceful application of the results thereof; and
>
> "(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment."

2. National Aeronautics and Space Administration

The National Aeronautical and Space Administration was established by Section 202. Section 203(a) authorizes the NASA to:

> "(1) plan, direct, and conduct aeronautical and space activities:
>
> "(2) arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and
>
> "(3) provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

Additional provisions authorize the means by which NASA can discharge these functions.

3. Definitions

Section 103 defines the key terms appearing both in the NASA charter and the National policy.

"Sec. 103. As used in this Act-

"(1) the term 'aeronautical and space activities' means (A) research into, and the solution of, problems of flight within and outside the earth's atmosphere, (B) the development, construction, testing, and operation for research purposes of aeronautical and space vehicles, (C) the operation of a space transportation system including the Space Shuttle, upper stages, space platforms, and related equipment, and (D) such other activities as may be required for the exploration of space; and

"(2) the term 'aeronautical and space vehicles' means aircraft, missiles, satellites, and other space vehicles, manned and unmanned, together with related equipment, devices, components, and parts."

B. Current National Space Policy

The National Space Policy announced by the President on July 4, 1982, and set forth in National Security Decision Directive No. 42, reaffirms the national commitment to the exploration and use of space in support of our national well-being, and defines the following basic goals for U.S. space activities:

- Strengthen the security of the United States.
- Maintain United States space leadership.
- Obtain economic and scientific benefits through the exploitation of space.
- Expand U.S. private sector investment and involvement in civil space and space-related activities.
- Promote international cooperative activities in the national interest.
- Cooperate with other nations in maintaining the freedom of space for activities which enhance the security and welfare of mankind.

This policy reaffirms the U.S. commitment to the exploration and use of space by all nations for peaceful purposes and the benefit of mankind, but it also allows for space activities in pursuit of national security goals. It encourages domestic commercial exploitation of space capabilities, technologies, and systems for national economic benefit. It recognizes that there are two distinct but strongly interacting space programs --

national security and civil -- and reaffirms the necessity for close coordination, cooperation, and information exchange among these programs to avoid unnecessary duplication. Finally, the policy statement reaffirms that the Space Transportation System is the primary space launch system for both national security and civil government missions.

The policy gives high priority to the STS as a critical national space resource and to its effective utilization. For the civil space program, the policy outlines a balanced strategy of research, development, operations, and exploration as related to science, applications, and technology. It also calls for a climate which is conducive to expanded private sector involvement and continued international cooperation where sufficient benefits accrue to the United States.

The principal feature of this directive is the clear mandate for two separate space programs, military and civil, with the requirement for close cooperation between them. The policy in fact requires the U.S. Air Force to employ the STS for its missions, with any exceptions justified to the OMB and the President. Other features of this policy include a broadening of the principle for commercial exploitation and emphasis on benefits to the U.S. in cases of international space cooperation. The activities of NASA as provided for in the Space Act, as amended, are not further limited by this policy statement, consistent with Administration and Congressional actions on program and budget approvals.

In May 1983, the Administration announced issuance of a President's Directive on Commercialization of Expendable Launch Vehicles consistent with the National Space Policy and designed to encourage U.S. private sector investment and involvement in civil space activities. The basic goals of U.S. space launch policy stated in the Directive are to:

> "(a) ensure a flexible and robust U.S. launch posture to maintain space transportation leadership; (b) optimize the management and operation of the STS program to achieve routine, cost-effective access to space; (c) exploit the unique attributes of the STS to enhance the capabilities of the U.S. space program; and (d) encourage the U.S. private sector development of commercial launch operations".

The policy includes U.S. Government endorsement of the commercialization of expendable launch vehicles (ELVs), provisions for appropriate U.S. Government support of such activities, constraints dictated by legal, safety, and security considerations, and guidelines for pricing of support without subsidization.

The policy also states that the U.S. Government will continue to make the Space Shuttle available for all authorized users--domestic and foreign, commercial and governmental--subject to U.S. Government needs and priorities. Through FY 1988, the price for STS flights will be maintained in accordance with the currently established NASA pricing policies in order to provide market stability and assure fair competition. Beyond this period, it is the U.S. Government's intent to establish a full cost recovery policy for commercial and foreign STS flight operations.

C. Aeronautics Policy

The Administration's aeronautical research and technology policy was released in November 1982. The following are the key points of this policy:

- Technical superiority in aviation is required for national defense.
- The industrial base required for national defense depends on the health of the civil aeronautics manufacturing industry.
- Large gains in aircraft quality are foreseen; these are essential for national security and the continued success of U.S. industry.
- Civil and military aeronautical research and technology development have much in common.
- A disincentive exists for industry-funded research and technology development because its benefits are not capturable.

On the basis of these findings, the policy recommends that the national goal for aeronautical research and technology be to ensure timely provision of proven technology to support development of superior U.S. aircraft and an environmentally compatible air transportation system. The policy also recommends that the U.S. Government support civil and military aeronautical R&T, and also military aeronautical technology demonstration, consistent with its overall priorities and the availability of funds. The present institutional framework should be maintained; NASA will fund, direct, and conduct aeronautical R&T development programs, support military aeronautical technology demonstration programs, and, with the Department of Defense, manage, maintain, and operate aeronautical research, development, test, and evaluation facilities.

APPENDIX 3

STUDY APPROACH

A. Initial Steps

After creation of the Task Force and the initial membership selection, the Task Force held its first meeting on December 1-2, 1982, at NASA Headquarters to develop a sound background on National and NASA policy and programs and to plan the study in detail. As a result of the planning session, a list of eleven issues bearing on NASA's missions were identified and written up briefly for further consideration. At the second meeting of the Task Force (January 16, 1983), the list of mission issues for consideration was narrowed; the statements of issues, questions, and factors for consideration were sharpened; and small subgroups were established to investigate individual issues and prepare short papers proposing Task Force positions on the issues. The issues and the respective subgroups were as follows:

- NASA's Mission in STS Operations - Anders, Dews, Fletcher, Stewart
- NASA-DOD Relationships - Oder, Withington
- NASA's Mission in Space Research, Technology, and their Applications - Baldwin, Harter, McCormack
- NASA's Mission in Space Science - Goody, Hinners, Margulis

The Task Force intended initially to include NASA's mission in aeronautics as a principal issue for consideration but, given the Administration's Aeronautics R&T Policy Statement in November 1982, agreed that no major issue remained. Member Withington agreed to write a proposed Task Force position to tie up any loose ends.

At later dates, two other issues were identified for consideration:

- International Relationships - Fletcher, Solomon
- Human Spaceflight Research - Dews

As the study progressed, it was decided to separate the space science mission into two parts, one on science conducted to increase knowledge, and the other on science conducted to yield direct human benefit (currently centered on solar system exploration and earth science). Also separated were the issues of NASA's mission in space research and technology and that in space applications. Finally, the separate notes prepared for the issue of NASA-DOD relations were incorporated within the subject areas to which they related, namely STS Operations, Space Technology, and Aeronautics.

B. Fact Finding

During the period from February through July, the subgroups made numerous fact finding and site visits to a large number of people where knowledge of the issues and factors under consideration could be acquired to assist the subgroups to develop positions for the Task Force's consideration. The lists of contacts made during this period follow:

1. STS Operations Subgroup

NASA

Administrator
Deputy Administrator
Associate Deputy Administrator
Associate Administrator for Space Flight
Assistant Associate Administrator for Space Flight (Policy)
Director, Space Shuttle Operations, OSF
Director, Customer Services, OSF
Director, Advanced Programs and Plans, OSF
Director, Space Station Task Force
Director, Commercialization Task Force
Director, Johnson Space Center
Assistant to the Director (Plans), JSC
Program Manager, National Space Transportation Systems Program Office, JSC
Deputy Director, Marshall Space Flight Center
Manager, Shuttle Projects Office, MSFC
Director, Program Development, MSFC
Director, Kennedy Space Center
Deputy Director, KSC
Director, Shuttle Management & Operations, KSC

United State Congress, House of Representatives

Staff Director, Subcommittee on Space Science and Applications, Committee on Science and Technology,

Office of Science and Technology Policy

Assistant Director for National Security and Space

United States Air Force

Under Secretary of the Air Force
Director of Space, Deputy Chief of Staff for Operations, Plans and Readiness

Comsat Corporation

Chairman and Chief Executive Officer

2. NASA-DOD Relations Subgroup

NASA

Associate Administrator for Aeronautics and Space Technology
Director, Aeronautical Systems Division, OAST

United States Air Force

Under Secretary of the Air Force
Director, Space Projects, Office of the Secretary
Commander, Space Division (now retired)
Deputy Commander, Space Division (now Commander)

United States Navy

Deputy Assistant Secretary for Research, Applied and Space Technology

United States Congress, House of Representatives, Committee on Science and Technology

Member (Minetta)
Staff Director, Subcommittee on Space Science and Applications
Technical Consultant (Mj), Subcommittee on Transportation, Aviation and Materials

Industry

Various individuals from McDonnell Douglas, Lockheed, General Electric, Pratt & Whitney, and Boeing

3. Space Technology Subgroup

NASA

Associate Administrator for Space Science and Applications and staff
Deputy Associate Administrator for Aeronautics and Space Technology and staff

NOAA

Director of Satellite Operations

National Research Council

President, National Academy of Engineering
Members, Space Applications Board

Fairchild Space and Electronics

President

Consultants

Willis H. Shapley
Leonard T. Crook

4. International Relationships

Department of State

Chairman, Planning and Policy Council
Under Secretary of State for Security Assistance, Science and Technology

Office of Science and Technology Policy

Director

United States Congress, House of Representatives, Committee on Science and Technology

Chairman
Chairman, Subcommittee on Space Science and Applications
Immediate Past Chairman, Subcommittee on Space Science and Applications

NASA

Director, International Affairs Division

European Space Agency

Director General

5. Space Science Subgroup

The group studying the space science issues chose a different approach, that of soliciting written inputs from a host of people knowledgeable on various aspects of the issues, and responding to postulated statements of NASA's missions in space science. The form letter and its enclosed postulates, attached to this Appendix, were sent to 115 people, including scientists, science writers, involved lay people, members of the political community, and the members of both the Task Force and the NASA Advisory Council. The response was just over 40 percent (primarily from those with science or technology interests) and the resulting Task Force recommendations represent the overwhelming consensus.

C. Subsequent Task Force Meetings

Meetings of the Task Force itself were held on March 25 and June 9, 1983, so that the subgroups could report on their respective findings and areas of interaction could be identified and worked. From August 10 to 12, 1983, the Task Force met at the Woods Hole Oceanographic Institution to prepare its report. At that meeting, the broad "MISSION OF NASA" statement of section B of the report, as well as most of the more detailed parts of section C, were drafted. The material there prepared was compiled as a complete draft report and sent out for review shortly after September 1.

In addition to review by the full Task Force Membership, comments were solicited from nine outside reviewers. Responses were received from eight of these reviewers, and were generally supportive of the Task Force's report. Their suggestions to strengthen the report's logic and recommendations were incorporated appropriately. The final draft report was presented to the NASA Advisory Council for its approval at its meeting on October 11, 1983.

Attachment - Science Survey Letter

<Title> <F Name> <L Name>
<B Address>
<City>, <State> <Zip>

Dear <LB Salut>:

James Beggs, Administrator of NASA, has asked a small advisory committee led by George Solomon to make recommendations to him on the "Mission of NASA", to include, if needed, recommendations for modifying the Space Act itself.

This is the first time, to our knowledge, that an inquiry of such breadth has been undertaken by the Agency. As members of the committee we have been asked to make recommendations with respect specifically to science policy and we feel an obligation to work toward a thoughtful result.

We have framed our ideas into a statement and two sets of questions with regard to space science, exploration, and earth observations, respectively. These are each obviously debatable, and we would like to be able to present a reasoned set of pros and cons, possibly with conclusions. We would also like to know whether we are missing any issues of great importance and if you concur that our statements reflect an appropriate balance and emphasis with regard to NASA science.

We hope that you will be willing to respond to all or part of our inquiry at whatever length you choose. Any indication of your reactions will be valuable, but we must have them soon in order to do our job. Please send your response to Nathaniel B. Cohen, Code LB-4, NASA Headquarters, Washington, DC 20546. An addressed envelope in enclosed for your convenience.

Thank you for any help you can give us.

Sincerely,

Richard Goody
Harvard University

Lynn Margulis
Boston University

Enclosure

Enclosure to Science Survey Letter

The NASA Mission in Space Science, Exploration, and Earth Observations

a. Space Science

Science is both a means for the achievement of national and international objectives and a major cultural element in U.S. society. There are many organizations, both in and out of government, that play major roles in these sciences. NASA's space flight missions offer unique opportunities for scientific research in the space sciences; these include astronomy and astrophysics, earth and planetary science, space physics, and solar-terrestrial physics. The U.S. commitment to increasing fundamental knowledge through scientific investigations in space, and the central role played by NASA, is reaffirmed.

b. Exploration, Leading to the Eventual Utilization of the Solar System for Human Benefit.

NASA has carried out a spectacular and successful program of exploration of the Moon and planets. A mission-by-mission approach has fallen into difficulties because of budgetary conflicts and the increasing cost and complexity of equipment needed for the most innovative scientific investigations.

It is important to determine to what extent the U.S. has a long-term objective arising from our ability to move at will throughout the solar system. Can we envisage an eventual utilization of the solar system for human benefit? Although it is impossible now to identify the projects feasible in the next half century, the research directions needed to provide the basis for such project can be stated and are feasible. Should there be a commitment by the Agency to pursue a program in support of this long-term goal? Is a role for man essential to the next phase of exploration? Can and should our aspirations be set aside until more propitious budgetary conditions recur? Will this result in an unacceptable loss of our leadership role with respect to the USSR, Europe, and Japan? Can we maintain our skills and support systems (e.g., the deep space network) through a period of exploration inactivity by means of reliance on DOD technology?

c. Earth Observations

Through public statements and its participation in many international programs, the U.S. has continually demonstrated a commitment to the use of its scientific and technical capabilities to increase our understanding of the Earth, its environment, and the human impact on that environment. The strategic tools for such research are increasingly satellite observations, but because of limitations inherent in NASA's responsibilities, NASA's past activity in this area has been more narrowly focused and perhaps less productive than in those areas where it has an overall mission responsibility. The Global Habitability concept has been proposed as a focus for NASA's many Earth observations activities and an area in which the Agency could, with collaboration from others, play a leading role. The proposal is drawing increasing interest from the U.S. and international science communities. The commitment, if undertaken, is long (decades) and large.

Is a focused program of Earth observations for global research in areas of human concern an appropriate space initiative? If so, is it appropriate for NASA to assume leadership of such a program (Global Habitability or other) as a large and long-term commitment? To what extent will Agency commitments and responsibilities need to be changed to accommodate such an activity?

APPENDIX 3

REVISED TESTIMONY: November 18, 1983

Changes, by Dr. Donahue, are highlighted.

cc to Pete [illegible]

STATEMENT BY

Thomas M. Donahue
Chairman, Space Science Board
National Academy of Sciences

BEFORE THE

Subcommittee on Science, Technology, and Space
Committee on Commerce, Science, and Transportation
United States Senate

DIRECTION OF THE DEVELOPMENT OF A CIVIL SPACE STATION

Tuesday, November 15, 1983
Room SR-253, Russell Senate Office Building

Thank you Mr. Chairman for your invitation to testify on the space station issue. My name is Thomas M. Donahue; I am on the faculty of the University of Michigan and am the chairman of the Space Science Board of the National Academy of Sciences. It is the ongoing task of the Board to provide independent advice and guidance to the conduct and substance of the U.S. civil space science program and the major technical initiatives to implement such programs.

The Space Science Board recently produced two brief reports dealing with space science issues raised by NASA's proposal to establish a space station in a low inclination orbit by the end of this century. I have attached these reports to this statement along with the transmittal letter that I sent with them to Mr. Beggs, the administrator of NASA. So here I shall only very briefly summarize the content of these reports. The first report addresses the question of whether the space station now proposed would significantly enhance the usefulness of space science missions it proposes to support above the level they would achieve if the present space transportation system alone were available to launch and support them. In view of the fact that the mission set in question was designed around expendable launch vehicles, the shuttle and appropriate upper stages now being developed it is hardly surprising that the answer turned out to be negative. It is important to note that the Board addressed the question of how much we need this particular space station 40 percent of whose projected activity is stated to be support of a particular set of space science missions. We explicitly remarked that we could envision other kinds of space stations, designed to do other things such as providing an assembly base for construction of large structures or new kinds of space craft on orbit that might be very useful to space science missions of the future. We suggested that we might be able to get enthusiastic about such a space station. However, it is only fair to say that I doubt that these kinds of activities alone could ever come close to justifying entirely the establishment of such a space station. Indeed, we also pointed out in our second report our conviction that in defining the properties of a space station one should have very clearly in mind all of the major functions it is supposed to perform. To be explicit, if -- sooner or later -- the space station is supposed to provide a base for expeditions to Mars or to the Moon then that activity will so overwhelm the support of the platforms and free flyers of space science and applications that one should pay attention from the beginning to the requirements of the more ambitious application of the space station. I am not saying that the proposed space station will not serve well as a step toward that ultimate space station. I only point out that we have not seen the evidence that the issue is being addressed or that we understand the tradeoffs.

You might ask why we insist on evaluating the space station in terms of our present set of missions and do not consider revising them radically in view of the possibility that novel ways of configuring and servicing missions from a space station might be developed and provide us with exciting new capabilities. The answer is partly that we are not being challenged to do that with the present proposal. It is also partly that our plate is very full with the present set of missions. We are very excited about their potential to provide us with fundamental insights into how the universe began, insights into grand unified theories of physics, into questions about how the planets and the sun developed and life began, into how life on earth impacts and is impacted by changes in the atmosphere, the oceans and the solid planet. We consider this to be a very worthy agenda; we consider the technical means now becoming available adequate to allow us to get on with it, and, especially after our experience with long frustrating delays waiting for that system to be put in place, we are very resisting to risking another wait for another promised enhancement in supporting technology that, in our opinion, offers no apparent qualitative advantage over the shuttle system for science. That technology ought to grow in response to experience and evolving requirements and not to be artificially introduced in such a way as to drive its uses.

In fact it is significant that the pressure to build a space station is not coming from potential users such as space science and applications. Those who are pressing for a space station are making a laudable effort to involve those users in defining the characteristics of the space station so that it will be useful to them. This is in contrast with what happened when these communities were presented with the space shuttle and space-lab, two previous systems imposed on them. But, nevertheless, I have to emphasize the importance of the observation that technical means should develop in response to user needs and not the other way around.

It is often said that our response to the proposed space station is a consequence of our fears that science budgets will suffer from competition with Office of Space Flight budgets if the nation should embark on a new and ambitious space station program. This is not an accurate characterization of our position. A very simple examination of the record will reveal that the budget for space science has remained fairly close to a fixed fraction of the total NASA budget through all of the 25 year history of the space program. During the years of the Apollo era this fraction served to support a vigorous and productive science program. During the years of the shuttle it has not. The reason is that during the sixties and early seventies the science budget was being used to build space craft, to launch them, and to finance the science groups that used them. During much of the last ten years approved space science missions have been waiting on the ground to be launched because of delays in getting the shuttle operational and the unavailability of expendable launch vehicles. Thus the budget has been used to support the infrastructure of engineers and technicians that must be maintained to take care of these missions until they are launched and not to prepare and fly new missions. The rate of launching space science missions has dropped from 5 or 6 per year in the late sixties to about one per year now. Thus we have warned that, if the nation wishes to continue to do space science while a space station is being developed, the means to launch and support space science missions and to support the space science community will need to be preserved concurrently. Nevertheless, the budgetary impact may occur; we are watching with great interest to see what is in the agency's FY 1985 budget request. If the budget implication of large sums for the space station and for the consequences of management defects in developing the space telescope are failure to propose new starts for the Upper Atmosphere Research Satellite, for the Mars Geoscience Climatology Orbiter, the first planetary mission in the Planetary Observer series recommended by the Solar System Exploration Committee, or the various measures needed to bring emergency aid to failing university space science research groups the conclusion will be obvious. Early this year, after the magnitude of the problem with the space telescope development was revealed, we expressed to NASA and to the Congress our hope that the penalty for management failures would not be assessed against science. It is already clear, however, that the Advanced X-Ray Astronomy Facility and the Solar Optical Telescope are being delayed. Personally, I am apprehensive that delays also will be imposed on some or all of these other science missions that I have mentioned. If this turns out to be the case and at the same time funds are requested for a major new initiative for other elements of the space program, then a strong statement will have been made concerning priorities. If this is, indeed, the direction in which the nation desires to take its space program, that is its perogative. The duty of the Space Science Board is to make sure that the scientific consequences of such a decision are spelled out.

Let me return to the statements the Board has published on the Space Station for a moment. We recognize that space science and applications are not the only ends of the space program -- not by any means. We have not taken a position for or against the space station, although many read our position to be negative. We hold that the decision to build a space station will be made for reasons other than its usefulness to space science and applications alone. In this regard, we are not far from the position taken by Vic Reis this morning.We also recognize that a healthy space agency is necessary for a healthy space science program, and that permission to embark on an ambitious new program such as the space station may be necessary -- or at least very salubrious -- for the health of NASA. With these factors in mind we were reluctant to produce the judgement we did on the need of space science for this space station. However, the reason the Academies have established advisory bodies such as the Space Science Board and the Space Applications Board is to provide clearly independent advice on scientific and technical issues to those in government who must come to decisions on those issues. A crucial question is whether science can get along without the proposed space station, and how well it can get along. These questions are very different from the question of whether we could use the Space Station if it were to be built, or could use some kind of space station which may not even be the one proposed. Earth Sciences, for example, need observatories in high inclination, sometimes sun-synchronous, orbits. Such platforms and free flyers could benefit from services rendered by a manned space station in a high inclination orbit. But they could also be serviced from a space shuttle sortie in such a high inclination orbit. Thus to say that these observatories would be benefited merely because they are part of an overall plan, labelled a space station plan, that does not provide for the matching manned space station element would be an empty endorsement. It is one that we chose not to make.

I hope that these remarks, coupled with the documents I have submitted will clarify some of the issues you must confront or provoke questions that I shall be pleased to try to answer.

NATIONAL RESEARCH COUNCIL
COMMISSION ON PHYSICAL SCIENCES, MATHEMATICS, AND RESOURCES
2101 Constitution Avenue Washington D C 20418

SPACE SCIENCE BOARD

OFFICE LOCATION
JOSEPH HENRY BUILDING
21ST STREET AND
PENNSYLVANIA AVENUE N W

September 9, 1983

Mr. James Beggs
Administrator
National Aeronautics and Space
Administration
Washington, D.C. 20546

Dear Jim:

Last September the Space Science Board agreed to work with NASA in determining the technical capabilities a space station should have in order to address effectively the scientific objectives of the various space science disciplines. During the past year, the Board and its committees have had frequent interactions with the NASA Space Station Task Force, led by John Hodge, in fulfilling that commitment. We have been very favorably impressed by the careful consultation with the community of potential space station users that NASA has maintained during this exercise. In due time, we plan to transmit to you formally the results of the past year exercises by the Board and its committees.

Mr. Hodge has briefed the Board concerning the characteristics of the space station now being proposed by NASA. In the reports enclosed with this letter, the Board addresses two separate issues. The first issue is the degree to which the space station now being considered will be required in order to reach the objectives of the Space Science disciplines during the next twenty years. This evaluation, in the Board's opinion, must be made in the light of the adequacy of the presently available space transportation system to meet space science needs without augmentation by the proposed space station capabilities. Our finding is that present systems are adequate to these needs. Therefore, on the issue of meeting the needs of space science, our recommendation would be to use the space shuttle, together with requisite upper stages, maneuvering and propulsion systems for missions to be flown during this century. To meet longer range science objectives, a space station might prove to be very useful in various ways if it were suitably designed. The Board would be happy to work with you to define such a space station if you proceed with plans for it.

As we pointed out in our letter of September 13, 1982, the Board agrees with you that the question of whether to go forward with a space station is not apt to be made on the grounds of its usefulness to space

The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering to serve government and other organizations

science and applications alone. Thus, the report entitled "Space Science Board Assessment of the Scientific Value of a Space Station" should not be regarded as establishing a Board position on the question of whether the nation should or should not now or in the future develop such a space station. On the other hand, the Board has considered some additional issues that lie within its competence. These have to do with conditions that should exist as any space station is being developed and after it becomes operational, if a healthy and vigorous space science program is to be maintained concurrently. A discussion of these issues is the content of our second report, "Space Science in a Space Station Era" which is also being forwarded to you with this letter.

Sincerely,

Tom

Thomas M. Donahue
Chairman

cc: F. Press
P. Smith
H. Friedman

SPACE SCIENCE BOARD ASSESSMENT OF THE SCIENTIFIC VALUE OF A SPACE STATION

During the past year, the Space Science Board has examined the question of what space systems are required to launch and support adequately the space science missions designed to attain the high priority science objectives identified by the Board and its committees. These missions are very numerous, challenging, and exciting. However, the rate at which they are launched would have to increase significantly above the current rate if all of the missions needed to fulfill this program are to be flown during the next two decades. The means of launching and tending them is now available or being developed in the form of expendable launch vehicles and the space shuttle, augmented as required by adequate high energy upper stages. One reason for the present slow pace is the delay in bringing the shuttle and its upper stages to full operational status. Another is that we have not yet learned how to use the shuttle efficiently and effectively as a manned orbiting laboratory. The Space Science Board urges that the present launch systems be fully and flexibly exploited and adequate resources be brought to bear so that the stated objectives of space science can be reached in a timely fashion. The results of following this course should be a rich harvest of discoveries and insights in all disciplines of space science.

The Space Science Board has carefully examined the proposal by NASA for a manned space station in low Earth orbit designed to engage in a number of major activities. A significant portion of these activities involves support of space science missions. The Board has also examined the set of specific missions proposed for implementation from the space station system during the years 1991-2000. It has found that few of these missions would acquire significant scientific or technical enhancement by virtue of being implemented from this space station. In view of this and the adequacy of the present space transportation system for the purposes of space science, the Board sees no scientific need for this space station during the next twenty years.

In the longer term, the Space Science Board sees the possibility that a suitably designed space station could serve as a very useful facility in support of future space science activities. Such a space station could provide means for erecting and fabricating large and novel structures in space, and for servicing, fueling, and retrieval of payloads in orbit. If NASA wishes to develop plans for such an ambitious and technically demanding space station for the next century, the Space Science Board would be pleased to work with NASA in defining the properties of such a space station.

SPACE SCIENCE IN A SPACE STATION ERA

In a recent statement entitled, "Space Science Board Assessment of the Scientific Value of a Space Station," the Space Science Board has addressed the issue of the space science need for a space station. It found no need for a space station to support missions addressing high priority science issues for the next two decades. On the other hand, it found that a suitable space station could offer important services to space science in the more distant future.

The Space Science Board realizes that the nation may decide to commit itself to the deployment of a space station in support of needs and objectives other than or in addition to those of space science alone. The characteristics of such a space station should be carefully determined to conform to the principal activity that it is intended to support. For example, it is not obvious that a space station optimized as a transportation node for travel between the Earth and other solar system objects would also be an entirely suitable platform from which to launch and support science and applications missions. Whatever the eventual properties of such a space station, there will probably be a set of high priority science missions that require orbits and operational support for maximum effectiveness other than those available from that station. If a space station program should be undertaken and it is meant to be useful to space science, the Space Science Board urges that the means to initiate and operate space science missions in a timely fashion and in reasonable accord with priority ordering of those missions be maintained. Ordering of missions would then be determined by scientific priority rather than the nature of the launch or support system required. The Board also urges that the scientific program be structured so as to be protected from delay in space station development or changes in its capability.

The Board also wishes to make the following specific recommendations and observations.

Scientific instruments that can be deployed in orbits compatible with space station orbits should be flown in optimal scientific orbits and on separate platforms if that is necessary to preserve them from contamination, interference, and degradation of pointing stability and control that may be associated with the manned modules.

If the space station is designed to provide a servicing capability beyond that provided by the shuttle, that capability should allow retrieval of instruments from a wide variety of orbits.

The deployment of a space station designed in part to support space science implies an increase in the level of space science activity above that presently planned. If such a space station is to be utilized effectively, the space station system should be accessible and affordable for scientific use, and there should be a real increase in the level of support for that activity.

A commitment by the nation to long duration human space flight, whether in Earth orbit or beyond, calls for the establishment of a facility for space biological and medical research on the effects on individuals of very long exposure to the "low g" environment. In this sense, the relationship of the life sciences to a space station is a special one.

Thus, a manned space station could eventually provide significant opportunities for a number of disciplines in space science provided there is a commensurate increase in the total level of space science activity. Realization of those opportunities would depend on the extent to which the capability to carry out space science research is kept viable, important experimental and theoretical activity is continued, and new endeavors are initiated while the space station is being developed. After the space station becomes operational, realization of those opportunities would depend on the provision of a sufficient number and variety of flight opportunities, many involving unmanned space craft and flight to regions of space near the Earth and further out in the solar system at distances and locations inaccessible to a manned platform.

APPENDIX 4

EDWARD C. WELSH
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PHONE: (703) 524-2140

Oct.14,1983

Hon.Harold L.Volkmer
Chairman,Subcommittee on
Space Science & Applications

Dear Mr. Chairman:

Thanking you for inquiring of me,I do compliment you and your committee for holding needed hearings on space policies and coordination of the administration of such policies.I have little to suggest and possibly nothing you have not already thought of.However,my eight years as the first statutory Executive Secretary of the National Aeronautical and Space Council cause me to make a few suggestions re that Council.

The Council was a very valuable administrative and policy tool and could be again if it is used effectively as it was between 1961 and 1969. We were asked for ideas,listened to, and in many cases were followed. For example, major policies were recommended to the President after they were developed through an interagency method of coordination. On April 28,1961,I drafted and the Vice President sent to the President a memorandum evaluating how our space program stood relative to that of the USSR and concluded that we could be ahead "if we firm up its (space program) and employ its resources etc." and could do so "within this decade". It also projected a manned lunar landing within that time period. Of course,it urged an increase in the NASA budget for such objective.

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The meetings on which these recommendations were examined and discussed were actively participated in by the Vice President,the Secretary of Stata,the Secretary of Defense,the Administrator of NASA,the Chairman of AEC,and some of their assistants.Also, observers participated from the Bureau of the Budget, the Science Advisor,and others.

In another example,top level representatives from Council members and other interested agencies were brought together to develop a policy for communication satellites. After much discussion,the draft was was formally examined by the Council members and the Attorney General,approved, and sent on to the President.He had it issued as U.S. policy. Next,the President ask me to recommend how the policy should be carried out. All interested agencies were called in and we drafted a bill,which the President sent to Congress. It became law and the COMSAT Corp.came into successful existance.

These two examples are only cited to show the type of accomplishment a well coordinated Council operation can effectuate.

Consequently,I make several comments and recommendations:

1.Reactivate the National Aero.and Space Council,but only if it has positive support of the President.

2.Require a report by the Exec.Sec.of the Council at least once a month to the President and as often as is desired by the Congress on progress,lack of progress,or recommended changes.

3.Maintain separate responsibilities in space matters between NASA and Defense, which should be coordinated,if differences develop,through the Space Council.

4.Maintain the statutory or President's chosen membership of the Council,except on major aeronautical issues or policies bring in a top level representative from an appropriate agency such as the FAA.

5.Require that the Exec. Secretary of the Council or his representative be brought in to the Space budget considerations before the proposals are presented to the President,

6.NASA budgets should be based on five year policy and proposal projections rather than on short run fund competition with unrelated agencies.

I think the the policies and program objectives stated in the Space Act are adequate and need little change. To the extent that the ideas I have presented require language change or additions,they could be made clear as congressional intent in the Committee Report.

Edward C. Welsh
Edward C. Welsh

APPENDIX 5

SECTION BY SECTION ANALYSIS
NATIONAL AERONAUTICS AND SPACE ACT OF 1958 AS AMENDED

TITLE I - Policy and Purpose

(A) Space should be devoted to peaceful purposes.
(B)(1) general welfare and security of U.S. require provision be made for aeronautical and space activities.
  (2) establishment of civilian aeronautical/space agency
  (3) Defense - related activities remain under DOD
(C) Objectives of aeronautical/space activities:
  (1) expansion of human knowledge
  (2) improvement of aeronautical/space vehicles
  (3) development and operation of space transportation systems;
  (4) establishment of long range studies of aeronautical space activities for peaceful and scientific purposes;
  (5) preservation of U.S. as leader in aeronautical and space science and technology and in their application to the conduct of peaceful activities.
  (6) Information Transfer
  (7) International cooperation & peaceful application of results
  (8) Utilization of scientific & engineering resources of U.S.; close cooperation among agencies to avoid unnecessary duplication of effort.
(D) R&D directed toward ground propulsion systems, advanced automobile propulsion systems, and bioengineering.

Title II - Coordination of Aeronautical and Space Activities

Title II envisioned Federal-wide coordination of space activities through the National Aeronautics and Space Council and the Civilian Military Liaison Committee (both abolished). The functions of the Administrator are also delineated, include authorization to engage in international cooperative work.

TITLE III - Miscellaneous

This Title contains miscellaneous provisions including access to information, security arrangements, and property rights in inventions.

TITLE IV - Upper Atmospheric Research

This Title authorized in 1975 the establishment in NASA of an upper atmospheric research program.

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